Product 6

ETOLIN ISLAND AREA

Mariculture Pilot Project

Alaska Coastal Zone Management Program

Alaska Department of
NATURAL
RESOURCES

88

ETOLIN ISLAND AREA
Mariculture Pilot Project

Greetings:

We are pleased to present this final report of the Etolin Island Area Mariculture Pilot Project. Major elements of this project are:

1. An examination of biological and environmental issues of aquatic farm siting, and

2. A presentation of current permit and permit review processes required by state and federal agencies for establishing aquatic farms.

Other elements include a brief history of mariculture in Alaska, development issues, an examination of the Consolidated Shellfish Farm Application, project recommendations, and a summary of public comments received. Siting guidelines were developed as a result of environmental and biological investigations. The study is limited to shellfish and sea vegetable mariculture and does not address fin-fish farming issues.

This report is intended to be used primarily by state and federal agencies when processing or reviewing permit applications for aquatic farms. It should also be helpful to active or prospective sea farmers, and other individuals interested in the development of aquatic farming.

Six state and five federal agencies participated in the Etolin Island Area Mariculture Pilot project. Preparation of this report included literature reviews, interagency dialogue and cooperation, and field research in the study area. Public workshops were held in Petersburg and Wrangell, and a thirty day review period of a public review draft of the project provided opportunities for public involvement.

Aquatic farming is a relatively new and expanding use of tidelands in Alaska. Sea farming technology applicable to conditions encountered in Alaskan waters is evolving. State and federal agencies are responding to this new industry by developing permits, leases, review processes, policies and procedures to support development while at the same time providing for protection of all natural resources. This report presents an evaluation of processes currently adopted by industry and governing agencies.

Sincerely,

Andrew W. Pekovich, Acting Regional Manager

By: Terry W. Rader
Terry W. Rader
Project Team Leader

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Etolin Island Area Mariculture Pilot Project

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Alaska Department of Natural Resources
Division of Land and Water Management
Southeast Regional Office

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Project Team

The Etolin Island Area Mariculture Pilot Project report was prepared by a inter-disciplinary team of individuals representing state and federal agencies. This project team was coordinated by the staff of the Division of Land and Water Management, Department of Natural Resources. Following is the list of agency representatives who contributed throughout this project by researching, writing, reviewing, and contributing their expertise.

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Cooperating Agencies

Alaska Department of Natural Resources coordinated the project. The following is a list of cooperating and contributing agencies and a brief description of their primary areas of responsibility during this study:

State Agencies:

Department of Environmental Conservation (DEC) was responsible for water quality issues and information about the administration of the National Shellfish Sanitation Program.

Department of Fish and Game (ADF&G) contributed information on site capability, cultivation, and potential environmental impacts on habitat. ADF&G also provided information for the resource and use inventory.

Department of Commerce and Economic Development (DCED) provided industry viewpoints on development issues and explained development projects undertaken by the state to support mariculture development.

Office of Management and Budget, Division of Governmental Coordination (DGC) was responsible for information on the Alaska Coastal Management Program including coordination of the state's permitting process for projects in Alaska's Coastal Zone. DGC also contributed information on various aspects of permits and permit review systems.

Department of Natural Resources (DNR) was responsible for land use issues as well as overall project coordination.

Marine Advisory Program (MAP), University of Alaska contributed information on their Remote Sensing Project.

Federal Agencies:

U.S. Army Corps of Engineers (COE) provided information on Department of the Army permits and their review system.

U.S. Forest Service (USFS) provided information on their Special Use Permits and review processes and the resource and use inventory. They provided M/V Chugach and crew for field investigations.

U.S. Fish and Wildlife Service (USF&WS) provided use of the M/V Curlew and crew for field investigations. They also provided SCUBA divers for underwater investigations of existing and potential mariculture sites.

National Marine Fisheries Service (NMFS) provided assistance with on site SCUBA dives and technical review of the project.

In addition to offering expertise in their primary area of responsibility, all agencies provided clarifying comments and information throughout the study.

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Chapter 1

INTRODUCTION

PROJECT DESCRIPTION

Interest in aquatic farming in Alaska is growing. This interest is reflected in increased numbers of permit applications for aquatic farm projects and in legislative proposals addressing management of mariculture, including bills on shellfish, sea vegetables and finfish. The Etolin Island Area Mariculture Pilot Project was initiated to address this growing interest in aquatic farming, related land use, and the regulatory issues mariculture development raises.

This report is the result of a multi-agency pilot project. The project was funded by the federal Office of Ocean and Coastal Resource Management through the Alaska Coastal Management Program. The Alaska Department of Natural Resources coordinated the pilot project and development of this report.

In the Etolin Island Area Mariculture Pilot Project, participants studied shellfish and sea vegetable mariculture development in the Etolin Island area near Wrangell, in Southeast Alaska. This report presents results of the study. The project addresses major elements of mariculture development in a defined area. These include: biological needs of commonly cultivated mariculture species, effects of mariculture development on native environments, and use conflicts caused by siting mariculture facilities in certain areas. Based on this examination, project participants developed guidelines for siting and development of mariculture projects which are included in this report.

Permitting is important in managing mariculture activities because it provides a way to bring state policies and guidelines to bear them. The report describes permit systems set up by state and federal agencies to review and monitor mariculture projects. This permitting analysis will be useful background information for mariculture project applicants, state, and federal agencies involved in issuing or reviewing permits for mariculture development.

Municipalities may find the study useful when evaluating land and resource issues in areas similar to the Etolin Island Area. It should also be useful to individuals interested in starting a mariculture venture.

The study area was geographically limited to Etolin Island, Blashke Island, and the related island complexes in Southeast Alaska. The study area was selected because of high industry interest in locating mariculture projects in the area, and the absence of local and state land use plans for the area to guide coastal development.

This study is organized into five chapters:

Chapter 1 is a brief introduction to the project and provides an historical overview of Alaskan mariculture development. It also describes this project's relationship to federal, state and local planning processes.

Chapter 2 discusses site capabilities. This section explores biological and environmental needs of cultured organisms and various cultivation techniques. It also provides a discussion of paralytic shellfish poisoning.

Chapter 3 examines site suitability parameters. This is a detailed discussion of major issues involved in site selection to avoid negative environmental effects and impacts on other coastal users.

Chapter 4 explains permits that may be required for mariculture development, and review systems for mariculture projects. The Alaska Coastal Management Program is explained in this section.

Chapter 5 provides a summary of siting guidelines, implementation options and recommendations. Public comments are also summarized in this chapter.

Project Features

The following species were studied:

Oysters
- Pacific Oyster *(Crassostrea gigas)*

Scallops
- Weathervane Scallop (*Patinopecten caurinus*)
- Purple Hinged Rock Scallop (*Crassadoma gigantea*)

Mussels
- Blue Mussels (*Mytilus edulis*)

Kelp
- Giant Kelp (*Macrocystis integrifolia)*
- Kombu (*Laminaria ssp.*)
- Nori (*Porphyra ssp.*)

The study does not address projects which were outside the scope of state law as of January 1, 1988. As such, finfish mariculture is not considered within this pilot project.

This study will not be adopted as a DNR land use plan. There are several legally mandated steps that must be completed before a project can be adopted as a DNR Area or Management Plan. State adopted plans must address all resources and uses. As this study focuses only on mariculture, it will not be adopted as a plan.

Public workshops were held in Petersburg and Wrangell on two occasions during the project. The first workshops were held in late February 1988 and provided an opportunity for local residents to contribute information on resources and uses of the study area.

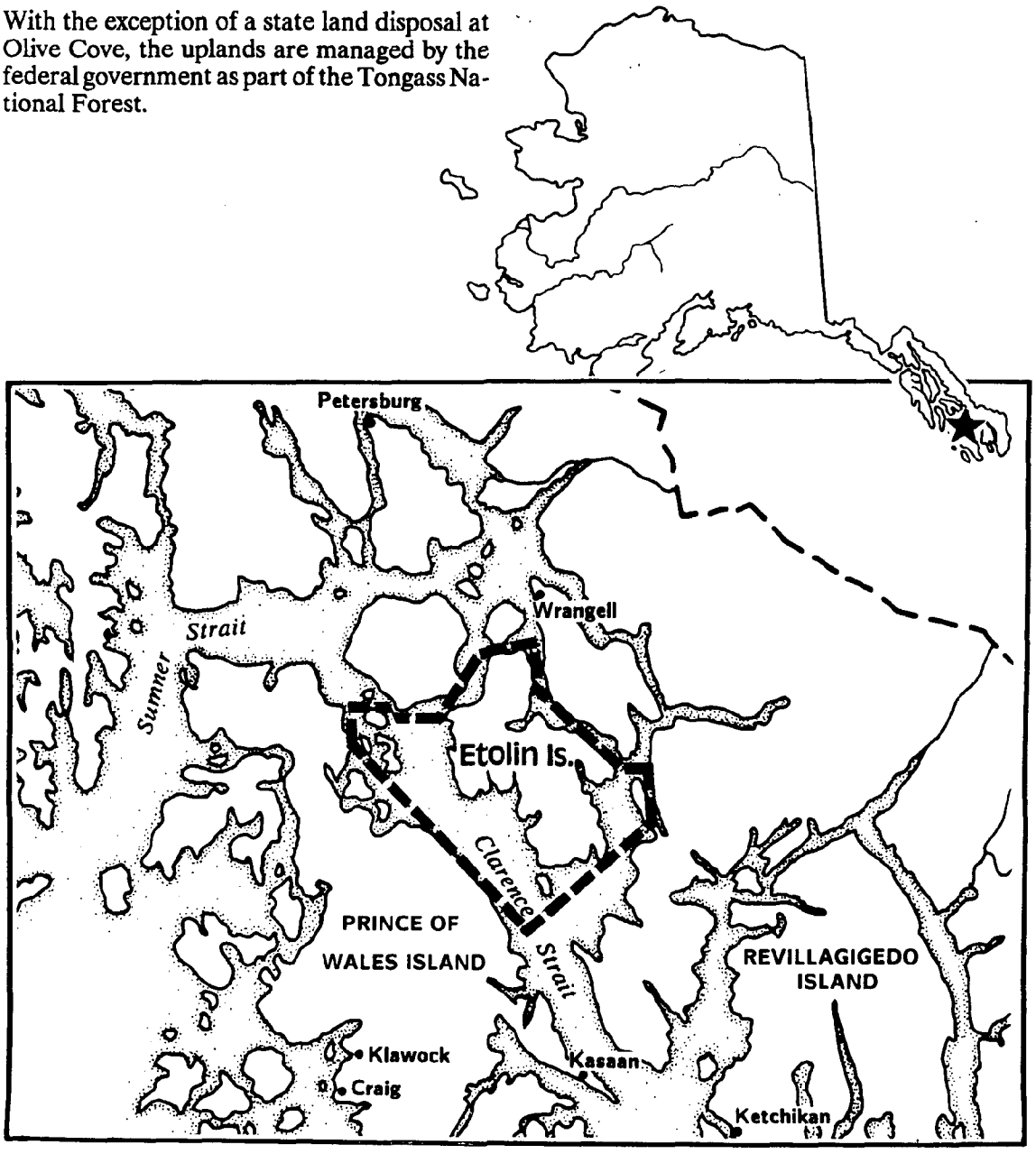
The second set of workshops were held in June and were attended by representatives of most cooperating agencies. Public comments on the project were accepted at these public hearings and in writing or by phone during a 30 day public review period from June 1 through June 30. Public comments are summarized in Chapter 5.

Study Area

All of Etolin, Deer, Onslow, Eagle, Stone, Brownson and Kashevarof Islands and the adjacent smaller islands are included in the project area. The state manages approximately 60,000 acres of tide and submerged lands adjacent to the island from mean high water seaward to three miles offshore.

With the exception of a state land disposal at Olive Cove, the uplands are managed by the federal government as part of the Tongass National Forest.

This island group is located southwest of Wrangell and is remote from any major population center. These islands can be characterized as containing mountainous forested uplands, extended inlets, and multiple island groups, surrounded by estaurine coastal waters.



DEVELOPMENTAL HISTORY

Shellfish and Sea Vegetable Mariculture History in Alaska

Mariculture efforts in the Pacific Northwest have focused on Crassostrea gigas, the Pacific oyster. It was brought to Washington State in the late 19th century from Japan and subsequently transplanted to British Columbia (B.C.). By the 1920's significant shipments of seed were coming into B.C. from Japan, and intertidal culture techniques were being developed.

Nearly eighty years ago seed oysters from Japan were first planted in areas extending from southeastern Alaska to Kachemak Bay on Cook Inlet. From 1910 to 1961 Pacific oyster seed was planted with little success except in the areas of George and Carroll Inlets near Ketchikan. This area proved moderately productive for oyster culture and was used for 50 years. Tidelands were leased from the federal government under the Oyster Bottom Leasing Act from 1937 until 1960 when the State of Alaska assumed responsibility for tideland leases.

In 1938, the Alaska Oyster Company leased about 300 acres of Coon Cove and Shoal Cove, both located in Carroll Inlet, for culturing purposes. A minimal amount of oysters were marketed from this venture before it went out of business in 1953. North Gem Oyster Company of Ketchikan leased 10 acres on the east shore of George Inlet in 1955 and added to their holdings each year until they held 247 acres by 1957. The company planted its acreage with 7,000 spat per acre in 1955, 5,500 per acre in 1956, and 28,600 per acre in 1957. In April of 1955 North Gem Oyster Company began an experiment with raft culture on the east shore of George Inlet opposite Beaver Falls. This was the only known trial of raft culture in Alaska during that time period.

Newly reorganized, the Alaska Oyster Company took over the North Gem holdings in 1960. During the winter of 1960-61, 200 gallons of shucked oysters were sold locally. This company planted 700,000 spat in 1960 and 2 million spat on 227 acres in 1961.

In the mid 1970's several additional individuals became interested in growing oysters and from their interest and efforts the present industry has grown. Robin Larsson of Wrangell, and Warren Pellet of Sitka, were instrumental in moving the industry from the extensive production methods of the beach and bed methods to the intensive surface tray and net methods currently used. Robin Larsson brought spat into the Etolin Island area in June of 1978. Mr. Larsson experimented with large rafts so oysters could take advantage of the warmest water. This also reduced natural enemies. He eventually formed a new Alaska Oyster Company and was issued a shellfish handler's permit. The first sale of oysters from this company occurred in August, 1983.

In summary, the oyster culture industry in Alaska began in the early 1900's and has continued sporadically to present. Early attempts at culturing oysters have been undertaken by undercapitalized and inexperienced companies. From 1983-1988 a renewed interest in culturing oysters brought about a significant fledgling industry which spread predominantly among the remote islands of Southeast Alaska. Specific information about oyster culture in Alaska has been compiled in the Alaska Oyster Grower's Manual funded by Department of Commerce and Economic Development and the Alaska Marine Advisory Program.

Blue Mussels Mytilus edulis grow naturally throughout most Alaskan coastal waters. Enormous amounts of seed are produced naturally each summer in most coastal areas. Present culturing efforts are located in Kachemak Bay near Homer. To date, 10 mussel farm project reviews have been initiated for this area.

In Alaska there has been a growing interest in scallop culture. Major efforts have been underway to locate scallop larvae near Kodiak Island. Scallop culture has been researched in British Columbia where various projects and commercial attempts have focused on collecting wild seed and devising cost effective ways of growing it to market size.

Commercial culturing of sea vegetables was legalized in 1988 under Chapter 145 SLA 88. The only Alaskan research on sea vegetable growth has occurred at Sheldon Jackson College in Sitka. This continuing laboratory research on Macrocystis has been occurring over a three year period. In the fall of 1988 a major project involving ocean growing of Macrocystis will be initiated at the college.

Economic success of shellfish or sea vegetable farming is unpredictable. Technology for culturing these species is developing rapidly. Very little actual culturing has occurred in Alaska to date with the exception of oysters. Interest in aquatic farming has remained high despite the unknown nature of the business.

Legislative/Administrative History of Mariculture in Alaska

During the 1980's considerable interest has been expressed in an expanded mariculture industry in Alaska. Analysis of policy issues and development of measures to encourage and accommodate mariculture have been progressing. The following chronology describes significant administrative and legislative actions since 1985:

Chronology of significant administrative or legislative actions regarding mariculture in Alaska

January 1985: An Attorney General's opinion was issued that fish farming is neither unconstitutional in Alaska nor specifically authorized by state statutes.

July 1985: Governor Sheffield appointed an ad hoc Mariculture Advisory Committee and charged it with formulation of a workable and effective mariculture policy to guide mariculture development in Alaska.

January 1986: The ad hoc Mariculture Advisory Committee issued "A Philosophy for Aquaculture Development in Alaska" which addressed culture of aquatic plants and animals in fresh and salt water environments.

Late 1986: Concurrent bills (SB 106, HB 108) were introduced into the legislature that would allow mariculture in Alaska.

December 1986: A Report "Mariculture in Alaska" issued by the interagency Alaska Mariculture Technical Work Group summarized current regulatory framework for mariculture in Alaska and identified policy issues.

June 1987: A compromise bill passed the legislature which:

1) placed a moratorium on finfish mariculture until July, 1988, and

2) legalized shellfish mariculture by authorizing spat (juvenile shellfish) collection and use of spat in commercial aquatic farms.

An Interagency Mariculture Work Group was formed to work on specific tasks to implement this legislation.

July 1987: An Attorney General's opinion was issued confirming that ADF&G did not have statutory authority to issue permits for holding live fish for commercial fish farming.

Summer 1987: ADF&G developed a permit system for commercial collection of shellfish spat for mariculture and revised the Fish Transport Permit to be appropriate for the shellfish program.

Late 1987: ADF&G adopted new regulations governing shellfish farm permits. Several bills were introduced in the legislature to either allow aquatic farming under different types of regulatory frameworks, allowing finfish

mariculture, or extending the finfish mariculture moratorium.

January 1988: A report from the Interagency Mariculture Work Group provided to the Fisheries Cabinet included eight issue papers on land use, water quality, biological, and product quality issues and a matrix of how four other areas had addressed these issues and a description of present socioeconomic studies.

March 1988: The Consolidated Shellfish Farm permitting system was adopted with:

1) a consolidated application form for most ADF&G, DEC, and DNR permits and coastal zone consistency determinations; and

2) a coordinated permit process.

May 1988: A bill (Chapter 145 SLA 88) passed the legislature which:

1) extended the finfish mariculture moratorium until 1990,

2) legalized sea vegetable farming,

3) established additional regulation of shellfish and sea vegetable farming including the statutory requirement for DNR to identify sites for aquatic farms and hatcheries to be known as "districts", and

4) established an Alaska Finfish Farming Task Force.

PLANNING AND CLASSIFICATION

No state land use plan currently encompasses the study area. DNR Prince of Wales Island Area Plan includes areas to the southwest of the area. The uplands of the study area are within the Tongass Land Management Plan boundaries. There are no organized local governments in the study area nor has a coastal resource service area for local coastal management planning purposes been formed for any part of it.

The Etolin Island Area Mariculture Pilot Project will not be adopted as a DNR plan because of its limited scope and completion time frame. Resource inventories and initial attempts at developing management guidelines for mariculture in this project are similar to those developed in DNR plans for all resources.

Information presented and guidelines developed as a result of this project will be incorporated into an area plan if one is prepared. They may also be developed into a site specific plan and used as the basis for classification within the project area.

Aquatic farming development in areas covered by land use plans receive direction from guidelines presented in those plans. State and federal planning processes are a basic land use tool for development of any resource in Alaska. Land use classifications developed from DNR plans provide a basic guideline for approving mariculture activities on public land. The following discussions are presented to develop background information helpful in understanding how mariculture is currently viewed in the planning and classification process.

State Planning Process

Department of Natural Resources (DNR) performs four levels of land use planning which are: A Statewide Resources Plan, Area Plans, Management Plans and Site Specific Plans. State law requires these plans be consistent with local government land use plans to the maximum extent without undermining state interests.

All resource decisions made by DNR are documented within the Statewide Resources Plan. Development and management of each resource under DNR's jurisdiction are described in the Statewide Resources Plan.

Area plans implement the Statewide Resources Plan on a regional basis. They examine statewide allocations made by the statewide plan, provide guidelines for making management decisions by delineating primary and secondary uses, and desired results to be achieved through management. Area plans result in classification of state land based on allocation decisions of the plan.

After an area plan is completed, a management plan may be prepared. Management plans define in more detail how allocations and guidelines of an area plan will be implemented. A management plan is usually written for one or a few management units of an area plan.

Site specific plans can be written for sites not covered by an area or management plan. They are usually prepared for actions on state lands requiring classification.

State law requires all state land, including tideland, be classified prior to action which results in assigning any land use rights. The classification process is based on land use planning. Area plans specify land use designations for land in the study area. These designations are an evaluation of existing and potential uses and resources. To ensure multiple use and avoid conflicts, the allocations are accompanied by management intent statements which give direction to land managers and guidelines for applying specific land classifications.

The Alaska Administrative Code (AAC) provides regulations which are the basis of the

state land classification system. Land use designations are converted to appropriate classification by regulation. Several land use designations may convert to a single classification.

Alaska has adopted land and tideland classifications, including: settlement, wildlife habitat, reserved use, public recreation, resource management, and others. Mariculture is not currently a land use classification. Mariculture could occur under a variety of other classifications. Classifications are broader in scope than land use designations.

Mariculture in Area Plans

Area plans are currently being developed for two Alaska coastal areas with mariculture potential: Prince of Wales Island Area Plan and Prince William Sound Area Plan. Other area plans will be developed in the future.

Guidelines for mariculture are evolving and being developed in various offices throughout state government. Because of this evolution, area plans avoid rigid, inflexible guidelines. Instead, they initially develop general guidelines and indicate issues additional guidelines should address.

The Alaska legislature has declared a moratorium on finfish mariculture development to extend through June, 1990. Plan guidelines are not sufficient to address complex issues related to these types of mariculture. Should these activities become legal, area plans recommend development of policies for these activities prior to authorizing them. Policy development could take the form of a plan, study, or recommendations of a working group. Area plans identify some issues for policy development.

Mariculture discussion occurs for two levels of management in Prince of Wales Island and Prince William Sound Area Plans: 1) area wide guidelines give general management direction and limited siting criteria for mariculture and; 2) site specific management direction is provided to guide the state's response to potential competing uses.

Clarification of management intent reflects department policy requiring other activities to be compatible with designated primary uses. Mariculture sites have not been designated due to lack of sufficient data to identify appropriate sites.

In general, mariculture activities may encounter the following situations under area plans.

1. Areas which have not been designated for other specific uses or have been designated for other uses and resources which do not present apparent conflicts. It is reasonable to expect that in these areas it will be easier to obtain authorization for mariculture activities.

2. Areas that have been designated for other uses and resources which may present significant conflicts. Areas designated for log transfer or storage, mineral access, crucial fish and wildlife habitat, intensive harvest areas, developed recreation, anchorages, or adjacent to existing or proposed land sale areas may have significant conflicts. Siting mariculture activities in these areas may be more difficult. Mariculture can be authorized if the conflicts can be adequately addressed and if mariculture operations can meet the management intent and guidelines for the area.

3. Areas where specific requirements may be attached to mariculture locations or operations. For example, mariculture will **not** be sited within 300' of the mouth of an anadromous fish stream without the approval of ADF&G.

Offshore of Wilderness Areas or Wildlife Refuges, mariculture growing facilities that are submerged and do not impact the visual characteristics of the wilderness or refuge may be easier to permit than floating types. However, support or caretaker facilities will not be authorized in these areas.

4. Performance standards will be attached to permits or leases to ensure the area is used for the appropriate activity, use is economically viable, and the permit or lease is **not** used for speculation. Similarly, development plans will be required before approval of a permit

or lease. Stipulations will be determined during permit processing.

Area plans can provide guidance for mariculture in specific areas. This is to clarify policy implementation or to note specific circumstances affecting mariculture development.

Examples of proposed area plan guidelines include:

1. Where there is an existing community or state subdivision, mariculture may be allowed if it is consistent with land sale design and will not: 1) block access, 2) detract from the view of waterfront lots, or 3) require upland owners to meet higher sewage treatment costs.

2. Near proposed state land sales, mariculture may be permitted if adjacent uplands are: 1) unlikely to be used for residential settlement, 2) unlikely to be reserved for public use, or 3) where mariculture can accept a short term permit or lease.

3. Mariculture will not preclude floathomes in six limited area designations for floathomes in Prince of Wales Island planning area.

4. Areas known for high recreation or fish and wildlife harvest values are discouraged from mariculture if there are feasible and prudent alternatives.

5. In areas that have a high potential for mariculture development such as Sea Otter Sound in the Prince of Wales Island planning area, cumulative impacts of mariculture will be periodically assessed.

Alaska Coastal Management Program Planning

With passage of the Alaska Coastal Management Act in 1977, local governments, rural regions, and the state began to cooperatively manage use and protection of Alaska's coastal resources. Thirty-two coastal communities and regions worked closely with the state to prepare management plans that guide development in their respective areas and to take part in permitting decisions of proposed development projects.

These communities and regions, known as coastal districts, prepare management programs that include an inventory and analysis of their natural resources and policies for the management of coastal resources and development. Mariculture is a good example of coastal activity that can be effectively managed through a district coastal management plan. The City and Borough of Sitka and Kenai Peninsula Borough are currently preparing innovative policies to address mariculture development through their coastal management plans. The Etolin Island study area is not within the boundaries of any coastal district.

In addition to district coastal management plans, mariculture activities could be addressed through preparation of coastal management planning documents such as this study, which was funded by the Alaska Coastal Management Program. Areas Meriting Special Attention (AMSA) plans, described in Chapter 5, may be developed under the ACMP. AMSA plans also could be used to manage mariculture development.

U.S. Forest Service Planning Process

All uplands of the study area (with the exceptions of a state subdivision in Olive Cove) are part of the Tongass National Forest and managed by the U.S. Forest Service (USFS). Management of the national forest is guided by the Tongass Land Management Plan (TLMP).

The U.S. Forest Service is presently revising its land management plan for the Tongass National Forest including the Etolin Island area. The revised plan will provide specific direction on how resources on Etolin Island will be

managed. Recommendations in this study regarding capability and suitability of shorelines in the study area for mariculture development could be incorporated into the revision. An Environmental Impact Statement for the plan is required. When it is completed and the Record of Decision is signed, direction for management of mariculture facilities on uplands under Forest Service jurisdiction should be consistent with recommendations made in this study.

Although goals for the Tongass Land Management Plan are not mandated for waters below mean high tide, the USFS expects compatibility between management direction for their uplands and permitted activities on adjacent waters.

Until such time as the Revised Tongass Land Management Plan is completed, current Tongass Land Management Plan direction and guidelines will apply to mariculture. Depending upon public and U.S. Forest Service concerns, when federal lands are involved, further project specific environmental analysis and public disclosure through appropriate National Environmental Policy Act documents may be required.

Local Planning Process

Local governments have authority to prepare and enforce comprehensive plans and land use regulations to guide development within their municipal boundaries. Mariculture development within cities and boroughs could be regulated through implementation of local authorities. There are no local governments in the study area.

DEVELOPMENT

The Department of Commerce and Economic Development's Division of Business Development (and formerly the Office of Commercial Fisheries Development), has been significantly involved in evaluating the feasibility of mariculture in Alaska. DCED has actively pursued development of a state policy on mariculture, assisted in the formulation of the Alaska Mariculture Association, and advocated the establishment of the Governor's Mariculture Task Force in 1985.

DCED has assisted development of the mariculture industry by funding, contracting and supervising production of the following publications:

The Alaska Oyster Grower's Manual, Edition III, 7/87;

Mariculture in Alaska: a discussion of the issues involved in sea farming development in coastal Alaska, 1/87;

Mariculture in Alaska: an examination of government programs by the Alaska Mariculture Technical Work Committee, 12/86;

Two organizations have been active in promoting mariculture in Alaska. The Alaska Shellfish Growers Association (ASGA) and the Alaska Mariculture Association (AMA). ASGA is the older of the two, and serves the growers through information exchanges and lobbying on issues pertaining to shellfish mariculture. AMA was formed in 1986, and supports the rational development of all forms of mariculture. AMA has been involved in supporting Alaskan involvement in finfish mariculture, whereas the ASGA has remained on the sidelines in that controversial debate.

ADF&G has also been active on many fronts to encourage the development of mariculture in Alaska. ADF&G's Fisheries Rehabilitation, Enhancement, and Development Division (FRED) has a full-time mariculture coordinator working to develop this potential industry for the benefit of Alaskans in a manner that will minimize negative impacts.

DCED was instrumental in establishing the Alaska/Japan Fisheries Cooperation Committee, and in establishing mariculture technology transfer as the main cooperation projects in 1985. DCED jointly manages two projects with ADF&G in cooperation with the Japanese: 1) a scallop spat collection feasibility project in Kodiak, and 2) a macrocystis kelp farming feasibility project in Sitka.

OTHER MARICULTURE / RESOURCE STUDIES

Kodiak Scallop Spat Collection Project

ADF&G's FRED Division is involved in research to collect scallop spat in Alaska. The summer of 1988 will be the second season for scallop spat collection efforts centered in waters off Kodiak Island. This project is a joint effort of ADF&G and the Overseas Fisheries Cooperation Foundation (OFCF), a quasi-governmental Japanese foundation that funds projects promoting international good will.

These experiments represent the first phase of an Alaska-Japan project designed to test feasibility of farming weathervane scallops on Kodiak Island. The goal of the 1987 season was to determine whether wild weathervane spat can be caught in quantities sufficient for commercial farming application. If sufficient quantities of spat are collected, the tiny animals will be moved into cages where growth rates will be closely monitored. Efforts in 1987 took place in Kalsin Bay just outside the city of Kodiak and six other cooperator sites using collectors developed by Japanese scallop farmers. During 1988 the project will expand to more sites in the Kodiak area and to sites in Southeast Alaska.

In addition to setting collection gear, project personnel, which includes Japanese experts, are tracking environmental factors (water, temperature, salinity, and wind) and taking plankton counts which can be used to determine where and when to set collection gear in future years. A "how to" field manual on scallop spat collection is currently being prepared (Blackett and Kaill, in prep.)

Macrocystis Research

Commercial culturing of sea vegetables has not been tried in Alaska to any large extent. Initial research at Sheldon Jackson College in Sitka has been the focus of efforts to collect sporophylls of Macrocystis for release of gametophytes in a hatchery setting. Results from 1986 and 1987 experiments were successful laboratory propagation of Macrocystis fronds and subsequent attempts at a grow-out phase in waters near Sitka. Disturbance of grow-out plantings occurred in these urban sites so complete data on this venture has not been available.

Continuing research into Macrocystis propagation and out-planting is planned for fall of 1988 at Sheldon Jackson College in a joint FRED/OFCF project. The goal of this expanded effort is once again to produce Macrocystis fronds through hatchery procedures and monitor growth on an extensive number of plantings in waters off Sitka.

Marine Advisory Program (MAP) Remote Sensing Study

Feasibility of using remote sensing to identify the aquaculture potential of coastal waters.

This project involves the collection, interpretation, and practical application of environmental data gathered through remote sensing techniques. Study during this project will be restricted to a site with the same boundaries as the Etolin Island Area Mariculture Pilot Project. A primary objective of this study is to compare environmental requirements of oysters with analyzed data charts. The expected outcome will be delineation of estuarine areas with a significant potential for oyster culture. This procedure will assist in development of rational for coastal development and developmental strategies. If adopted throughout this region, it will further serve as a tool for establishment of unified coastal development policies and will help identify potential areas of conflict between coastal zone users. It is hoped that this means of data analysis will suggest additional avenues for conflict resolution.

Main objectives of this project are:

1) Application for remote sensing to compilation and maintenance of coastal resource catalogs;

2) Development of mapping techniques;

3) Establishment of a table of oyster growth requirements;

4) Delineation of potential oyster culture areas;

5) Technology transfer: a contribution to resource managers capabilities for using this type of technology;

6) Cataloging of waters: develop an interpretive process by which resource managers can delineate areas capable of supporting productive operations;

7) Multiple use: the project will suggest location of other economic activities;

8) Rational use of estuarine resources; and

9) Improved access to strategic resource information.

The Marine Advisory Program's main objective in this project is to develop a practical means of identifying wetlands capable of supporting productive oyster aquaculture in Southeast Alaska. An inquiry of this type would normally involve traditional oceanographic "direct sampling" techniques. Although a conventional study of this sort would provide analysis with high levels of precision, costs would be extreme and the surveyed area would be limited. Such studies remain essential in the second stage identification and verification of specific microenvironments determined to be suitable for aquaculture. Proposed strategies of applied remote sensing has seldom been used in the northeastern Pacific. This project plans to make a strategic compromise, sacrificing some of the precision associated with conventional studies, but gaining in terms of extent of area examined and speed of analysis.

Approximate conclusion date of the MAP Remote Sensing study is November 1988. Data generated prior to the conclusion of the Etolin Island Area Mariculture Pilot Project will be available for inclusion in the final report.

Southeast Alaska Subsistence Survey

The U.S. Forest Service, ADF&G, and the University of Alaska are cooperating in a study of personal use (i.e., noncommercial harvest) of fish, wildlife, and plants in Southeast Alaska. Data is being collected in the form of maps and narratives through interviews with community residents. Data collection will systematically identify where people collect what resources (eg., deer, bear, salmon, plants, berries, etc.) for personal use, how much they use, and areas of highest productivity.

Several communities which use the study area are included in the survey. Interviews were conducted in winter, 1988 but only preliminary mapped data for Petersburg and Wrangell residents was available for review during preparation of this report. More detailed information on use of specific areas and relative intensity of use by residents of these and other communities will be available in late summer, 1988, and should provide an important data base for use in state and federal decision making about prospective mariculture sites.

For more information on this study see Chapter 3, Fish and Wildlife Harvest.

Etolin Island Area

Mariculture Pilot Project

CHAPTER 2

Site Capability

Chapter 2

SITE CAPABILITY

SITE CAPABILITY ISSUES

Proper siting of mariculture developments is crucial for successful production. For that reason, site capability should be thoroughly investigated prior to installation of facilities, or large scale introduction of seed.

Site capability is defined for the purpose of this project as: "Environmental and biological ability inherent in a site to produce a marketable product, in a reasonable amount of time, safe for human consumption."

Site capability is determined by conducting an inventory of the site's environmental and biological properties and an evaluation of this data based on individual species requirements. This section will examine site capability for select species of shellfish and kelp.

Inventory and Evaluation of Site Capability Criteria for Selected Shellfish and Kelp

Potential of a particular site for farming of shellfish and/or sea vegetables is limited by a range of environmental and biological parameters. For purposes of the Etolin Island Mariculture Pilot Project, this potential is termed the site's capability. Mariculture site capability parameters include:

Temperature
Paralytic Shellfish Poisoning
Salinity
Dissolved Oxygen
pH Level (Acidity)
Estuarine Flushing Rates
Zones of Upwelling & Mixing
Substrate Composition
Stratification of Water Column
Phytoplankton Production
Fresh Water Discharge
Anoxic Conditions
Competitors
Predators
Parasites and Disease
Indicator Organisms
Waste Deposits
Turbidity
Water Depth
Tides
Current Velocity
Carrying Capacity of Estuary
Growth
Sewage and Industrial Pollutants
Wave Action

Relative importance of each criterion depends on the species and culturing technique being considered. Shellfish species considered for this project include Pacific oyster (Crassostrea gigas), blue mussel (Mytilus edulis), weathervane scallop (Patinopecten caurinus), and purple hinged rock scallop (Crassodoma gigantea). Sea vegetables considered the most likely candidates for culture in the Etolin Island area are algal genera Macrocystis, Laminaria, and Porphyra. Of the above species, the Pacific Oyster is the only one being successfully farmed in the study area. Culture techniques developed at other locations for different species would have to be used or adapted for use on indigenous species in the project area. Options to import species other than Pacific Oyster do not currently exist.

Pacific Oyster

Strategies and site selection criteria for establishing oyster farms in Southeast Alaska have been thoroughly examined by Page Else and Brian Paust in the Alaska Oyster Grower's Manual (Else, Paust, and Burns 1987). Most of the following material was obtained from this source. Growth of oysters in southeast Alaska is variable, as evidenced by the fact that it may take from two to four years to produce a marketable product. Growth rate depends on such things as water temperature, salinity, current velocity, and concentration of phytoplankton available for food.

Although oysters will grow subtidally to a depth of at least 50 feet, successful commercial culture in Alaska will probably be limited to a relatively narrow depth range. For various forms of suspended oyster culture, including raft and longline farming, the maximum depth required will be approximately 15 to 20 feet of water at low tide. Generally, warmest water, and therefore best growth, will be obtained nearest the water surface.

Water temperatures of 0-30 C can be tolerated by oysters. However, feeding ceases below 5 C. Good growth occurs at temperatures greater than 10 C, but optimal growth occurs at greater than 15 C. Oysters cultivated in the study area will be subjected to suboptimal temperatures for most of the year. However, one of the advantages of oyster farms in Alaska is water temperatures are rarely high enough to precipitate spawning. As a consequence, high meat quality is maintained throughout the summer.

Salinities of 5 to 37 parts per thousand (ppt) can be tolerated by oysters. Optimal growth occurs between 15 and 30 ppt. Lower salinities result in more water being absorbed by the oyster which imparts a bland flavor to the meat. At some locations, fresh water lenses created by runoff will impact salinity within the top 1 to 3 meters of the water column. For this reason, salinity should be measured at several depths and at various times of year to obtain a true salinity profile of the site.

Oysters are capable of withstanding levels of dissolved oxygen down to 2 mg/l. It is unlikely low dissolved oxygen will be encountered at prospective sites in the study area since expected values in the water column in marine environments range between 6 and 9 mg/l. In areas of poor water circulation, decomposition of accumulated fecal material from an oyster farm may contribute to production of ammonia or hydrogen sulfide under anaerobic conditions, both of which are toxic to oysters, even at low concentrations. If bottom culture is planned, consideration should be given to measuring dissolved oxygen.

Tidal flushing of farm areas must be sufficient to provide adequate salinity, dissolved oxygen, and nutrients. To accomplish this, current velocity in excess of 2 cm/sec is required. Best growth is obtained at flushing rates of at least one exchange per day (Brown, 1979). Currents of 9 to 75 cm/sec (moderate to fast current) provide highest feeding rates. Saline surface water should remain at culture sites during slack tide long enough to achieve some temperature elevation for increased oyster metabolism. Most phytoplankton available to oysters is produced elsewhere and carried to the site by currents.

Acceptable pH values of 7.9 to 9.0 should not be a problem at most sites. The normal pH range of seawater is 7.5 to 8.4, and seawater provides natural buffering.

Oysters are capable of tolerating turbid water conditions but feeding efficiency may be impaired by ingestion of indigestible material. Sites that are chronically influenced by suspended sediment may not be suitable for farms. With bottom culture of oysters, accumulation of silt is unacceptable.

Sites considered for shellfish farms must not be located near sources of industrial, municipal, or sewage pollution. Industrial pollutants such as sulfite waste from pulp mills adversely affect oysters. Heavy metals such as zinc, copper, and cadmium, as well as other organic and inorganic poisons often present in municipal wastewater, can accumulate in oyster tissues in amounts exceeding federal

standards. Fecal coliform bacteria will result in contamination of oyster products that are often consumed raw.

Growth of oysters is largely a function of water temperatures and concentration of food particles in the water column. An oyster farm should be established at a site capable of sufficient production of phytoplankton. Such sites usually exhibit some surface stratification of the water column. Nutrient input from upwelling and surface runoff, in combination with surface warming, results in necessary primary productivity. Sites with suitable productivity for oyster culture are usually favorable for growth of potential competitors also, including fouling organisms such as mussels, barnacles, algae, sponges, tubeworms, and bryozoans. Although fouling is unlikely to be fatal to oysters, reduced growth may result. Probably the most important impact from fouling is the increased cost associated with control. Biological control mechanisms described by Matt Dick (Else, Paust, and Burns 1987) should be employed wherever possible.

Predation on juvenile and adult oysters by sea stars, carnivorous snails, various crabs, some mammals, and aquatic birds is not likely to be an insurmountable problem in Alaska. Use of suspended culture will minimize predation by bottom dwelling animals. Physical barriers, such as nets to protect raft culture, are helpful but may add to farm costs.

Prospective shellfish farmers will want to avoid sites identified as having high concentrations of encysted forms of the dinoflagellates responsible for paralytic shellfish poisoning (PSP). The abundance of encysted PSP organisms in bottom sediments can be used as an indicator of the potential for future PSP outbreaks in the vicinity.

A shellfish farm should be relatively free from wind, wave action, and ice formation during the winter. Problems associated with these phenomena arise mainly from safety and structural damage rather than the oyster's inability to withstand disruption. However, damage to new shell growth caused by such disruption could result in lower growth rates. Oysters may stop feeding during disruption (Church, 1988).

Blue Mussels

Many biological and environmental parameters important for the culture of oysters also apply to blue mussel farming. Perhaps the most notable difference is that unlike oysters, mussels occur naturally throughout the study area and are well adapted to environmental conditions there.

Sites for mussel culture have similar basic requirements to those of oyster culture: a reasonable amount of shelter, good water quality and a fair amount of phytoplankton for food (Korringa, 1977). Jenkins (1985) lists the most important environmental parameters as: oxygen, salinity, temperature, food availability, depth, exposure, and pollution. As with oysters, various species of mussels are widely cultured throughout the world. In Alaska, commercial farming of mussels has been established in Kachemak Bay (Hemming and Hemming, 1984). Mussel growth in Kachemak Bay is reported comparable to that achieved in Puget Sound with harvestable mussels produced within one year.

Water temperatures in which mussels are capable of growth range from -1 C to 25 C. Optimal growth occurs from 10 to 20 C. (Magoon and Vining, 1981). Hemming and Hemming (1984) reported average summer water temperatures of 11.6 C at 10 feet. The highest temperature in their study was 12.5 C.

As with temperature, mussels can survive in a wide variety of salinities ranging from 5 to 35 ppt. Hemming and Hemming (1984) reported good success culturing mussels in salinities of 24.5 ppt. Herriott (1984) stated mussels would grow in salinities down to 17 ppt, but sites near rivers should be avoided because low salinity will interfere with feeding and clumping.

Dissolved oxygen concentrations will not be of major concern to potential mussel farmers as mussels can withstand anoxic conditions for

up to several days (Hemming and Hemming, 1984). However, conditions that could lead to low oxygen, such as poor circulation of water, may make sites unsuitable for other reasons.

Considerations for water depth at prospective sites are similar to those for oyster culture: depth must be adequate for the method of culture chosen. Herriott (1984) suggested a minimum depth of 6 fathoms for raft culture with 10 meter ropes. According to Magoon and Vining (1981), bottom culture appears to be impractical in most of Washington State because of heavy predation by bottom dwellers. Herriott (1984) listed some disadvantages of stake culture such as lack of extensive intertidal flats with suitable tidal ranges and severe predation by gulls. Suspended culture minimizes parasite infection and avoids production of gritty particles in tissues. Similar problems may exist in Southeast Alaska, relegating mussel farming to suspended types of culture apparatus (e.g., rafts, racks, or longlines). Loo and Rosenberg (1983) report best results from longline gear at 0 to 2 meters below the surface.

Predation by fish, gulls, and sea ducks could still result (Glude and Chew, 1982, Magoon and Vining, 1981). However, Hemming and Hemming (1984) report no overt signs of predation even though numerous scoters were sighted in the area. If predation becomes a problem, the only practical solution would be to place netting around the culture (Magoon and Vining, 1981). Sound devices have been used to scare away ducks but none have proven successful (Glude and Chew, 1982).

Fouling by organisms such as sponges, bryozoans, barnacles, and algae may restrict water flow and thus available nutrients (Magoon and Vining, 1981). Solutions to these problems are labor intensive (Herriott, 1984). Hemming and Hemming (1984) indicate barnacles were difficult to remove and left a white mark on the mussel shell that reduced quality. They suggest postponing installation of tube or longline gear until after barnacles have settled. Hemming and Hemming report growth of bryozoans and a heavy coating of silt on tube-cultured mussels. Turbidity is reported to influence growth of mussels (Herriott, 1984; Verica, 1982 in Hemming and Hemming, 1984); however, widespread existence of natural populations in areas of relatively high turbidity indicate it would not preclude mussel culture. Suspended solids have been measured as high as 1,200 mg/l near mussel beds in France where growth was comparable to areas with suspended solids between 10 and 50 mg/l (Hemming and Hemming, 1984).

Experiments by Rodhouse et al. (1985) indicate mussels are efficient filter feeders capable of removing more than half of the available chlorophyll and carotenoids from the water column over a partial tidal cycle. In order to achieve maximum growth rates, sites chosen for intensive culture should have high phytoplankton abundance and sufficient water exchange rates to maintain abundance (Herriott, 1984).

Annual reproductive cycles will influence mussel quality and time of sale. Mortalities have been observed just after spawning, especially on warm days (Magoon and Vining, 1981). Mussels grown in raft culture may need to be conditioned to keep their valves tightly closed when removed from water for PSP testing and sale.

As with all filter feeding shellfish considered for culture in the study area, incidence of encysted forms of the organisms responsible for PSP should be determined. Mussels become poisonous rapidly, but usually lose toxin faster than other clams (Magoon and Vining, 1981). In some areas, PSP may limit harvesting to periods during the winter time (Glude and Chew, 1982). Mussel farm sites in proximity to sources of industrial, municipal, and sewage pollution should be avoided. However, it may be impossible to predict potential problems with disease organisms and parasites in intensive culture situations (Jenkins, 1985).

Scallops

Initial attempts to begin capture and cultivation of scallops are underway in Alaska. Techniques developed and in use in Japan are

being tried in the Kodiak area and to a lesser extent in Southeast Alaska. Although technically and biologically feasible, Japanese techniques of using cages to culture scallops need to be modified for economic viability (Cropp, 1983). Commercial scallop culture is probably still 10 to 15 years away from development in North America (Talley, 1985). Virtually all attempts at scallop culture have been initiated at sites adjacent to natural populations of scallops (Aiken, 1987).

Two species, weathervane scallop (Patinopecten caurinus) and purple hinged rock scallop (Crassadoma gigantea), show some promise as candidates for farming. However, distribution of weathervane scallops in Alaska is different from that of related species being cultured in Japan and New Zealand (Blackett, 1987). Alaskan scallops tend to be confined to distinct beds of high density offshore, with numerous scattered pockets of low density nearshore; in Japan and New Zealand scallops are concentrated in more accessible nearshore areas. This distribution may have considerable implication on development of procedures to capture and harvest natural spat needed to initiate weathervane scallop culture. Techniques of releasing large numbers of juveniles to repopulate natural scallop beds may not be practical in Alaska.

In general, literature on scallop culture indicates scallops do not respond well to large fluctuations in water temperature and salinity, particularly when they are small in size. However, natural distribution of rock scallops suggests this species is flexible in temperature and salinity requirements (Leighton and Phleger, 1981). Low salinity may not be a problem for some species of scallops as evidenced by their occurrence in brackish water lagoons along the Sea of Okhotsk (Motoda, 1973). Scallop larvae subjected to salinities as low as 11 ppt and 17-30 ppt swam normally (MacKenzie, 1979). However, Olsen (1983) reports salinities less than 23 ppt were detrimental to normal rock scallop growth. More research will be needed on temperature and salinity tolerances of Alaska rock and weathervane scallops to define capability parameters needed for culture sites.

Rock scallop larval development is reported to be optimal at 12 C to 18 C (Leighton and Phleger, 1981). Temperatures in excess of 21 C may be fatal, especially at relatively shallow depths of less than 20 meters (Mottet, 1979; Motoda, 1973). Scallops may be acclimated to varying temperatures, especially to rising temperatures, and temperatures as low as -0.7 C can be tolerated (Aiken, 1987; Mottet, 1979). Since temperature is likely to be inversely related to water depth, culture near the surface may produce best results.

Wallace and Reinsnes (1985) considered temperature and food quantity to be the most important factors in Iceland scallop growth. Salinity and current speed were secondary factors. Mottet (1979) also considered growth rates to be proportional to temperature and phytoplankton concentration. Growth slows or stops during spawning. The condition of the adductor muscle is highest following spawning when scallops resume growth.

Culture growth appears dependent on density factors. Scallops of less than 2 cm are particularly susceptible to low oxygen concentrations because oxygen consumption is approximately three times greater than that of adults (Mottet, 1979). Growth of scallops in Japan has been shown to decrease as culture density increases (Ventilla, 1982; Ito, et al., 1975). Motoda (1973) stated high density should be avoided as accumulation of feces may result in anaerobic conditions with toxic production of hydrogen sulfide. This situation is likely to result only from extremely intensive culture situations.

Siltation has been shown to be detrimental to scallops as concentrations of .05% can stop movement of cilia (Mottet, 1979). Spat in size ranges of 17 to 19 mm are intolerant of siltation (Motoda, 1973).

Scallops have been shown to be intolerant of rocking motion caused by wave action on suspended culture gear (Magoon and Vining, 1981; Mottet, 1979; Motoda, 1973). If suspended types of culture are used, structures will have to be located far enough below the surface to avoid wave action. Shock absorbing structures may have to be incor-

porated into culture gear in some locations. Raft culture may not be appropriate for scallops because of wave action (Motoda, 1973). Culture at depths of 3 to 8 meters under the surface may be necessary (Motoda, 1973). Traditional cage culture may be inappropriate for rock scallops because of the animal's need to cement to substrate (Leighton, 1985). Church (1988) related that rock scallops grown in plastic cages eventually stop attaching to the cages. He suggested, however, that cage growth was extremely slow, perhaps requiring years.

Fouling of culture gear and the scallops themselves is a problem in some areas (Mason, 1983). Fouling by tunicates and mussels was a problem during culturing of rock scallops in oyster trays and required weekly cleaning of the trays (Leighton and Phleger, 1981). Motoda (1973) considered fouling a problem in cage culture because organisms cover the cage surface, thereby reducing nutrient and oxygen exchange. Gear fouling may be a problem because it increases buoyancy requirements for gear and adds to maintenance cost (Aiken, 1987). Blackett (1987) indicated scallop hanging culture has been unsuccessful in New Zealand largely because of fouling by mussels and other organisms. Growth rates were not appreciably better on hanging culture than for scallops grown directly on sea bottom. Mottet (1979) suggested some fouling may be beneficial in protecting scallops from predation by sea stars; however, it usually results in competition for food, hampers mobility, may prevent complete valve closure, or conversely, may hold valves closed. Boring sponges and polychaete worms, perhaps more appropriately classified as parasites, may weaken valves and cause scallops to waste energy on shell maintenance that could be directed at growth (Ventilla, 1982).

Sea stars generate the most important predator problems for a scallop farmer (Ventilla, 1982). However, except for bottom culture and spat collector bags, predation by sea stars should not be a major problem. Carnivorous snails, crabs, fish, gulls, sea ducks and other water birds are potential predators of scallops. Suspended culture should avoid all but piscine, avian, and mammalian predators. As with other shellfish farms, installation of nets may be necessary if predation becomes a problem.

Paralytic shellfish poisoning is not generally a concern with most species since only the adductor muscle is consumed and, in most species, it does not accumulate the toxin. However, rock scallops do accumulate toxin in the adductor muscle and harvesting this species should be closely monitored.

If North American markets are developed for whole scallops, the same concerns expressed previously for oysters and mussels would apply. Scallops concentrate high levels of heavy metals such as cadmium, mercury, silver, and arsenic and should not be cultured in polluted areas (Mottet, 1979).

Sea Vegetables

Sea vegetables are cultivated for different purposes including: human food, food for livestock, agricultural fertilizer, industrial paste for use in textile and plaster manufacturing, alginic acid for glue, food stabilizers, viscosity reinforcing agents, a water softener, dental molding material, and medical products, including anthelminthic drugs and agar. Production of sea vegetables for industrial purposes is probably not viable in Alaska (Kaill, 1988). Ninety percent of the harvest in Japan is used for human food. The potential is extremely limited in Southeast Alaska for development of a Japanese style sea vegetable industry (Olson, 1987). Stekoll (1987) suggests a commercial kelp mariculture operation could be feasible in Southeast Alaska if it were closely linked to the herring roe-on-kelp fishery in Prince William Sound or if a roe-on-kelp fishery were reopened in Southeast. Church (1988) suggested algae settling naturally on shellfish culture gear could be harvested and sold as a byproduct to supplement shellfish farm income.

Algal growth is primarily controlled by available light. Green algae grow in shallow water; brown algae at intermediate depths; and red algae in the deepest water. Sea vegetables

generally grow at depths less than 50 meters; most at less than 20 meters. Macrocystis and Laminaria are classified as brown algae; Porphyra (Nori) is a red algae. Contributing factors to successful culture sites in Japan are:

1. Relatively calm water, protected from severe storms that could tear seaweed loose.

2. Good growing conditions as evidenced by target species in the area. Light, currents, nutrients, and temperatures are conducive to plant growth and no industrial or sewage related pollution is present.

3. Culture site use is restricted by excluding any form of conflicting use (Olson, 1987).

Macrocystis does not occur in the Etolin Island area (Frye, 1915), but both Laminaria and Porphyra do. Research and development work would have to be done with the resident species to determine cultural parameters for farming. According to Lindstrom (1987) local species of Porphyra probably are not suitable for Nori production. Another potential option is to import Asian species already under cultivation. Concerns regarding importation of disease organisms need to be addressed.

For algae considered in this report, water temperature requirements are similar to those discussed previously for shellfish. The upper temperature limit for culture of Macrocystis pyrifera in China is 23 C. Optimal temperature for female gametophytes is 13 C to 17 C. Frye (1915) found naturally occurring kelp (M. integrifolia) at temperatures ranging from 8 C to 14 C in Southeast Alaska. Mumford and Melvin (1983) reported for raft culture of Laminaria japonica in China that temperatures from 1 C to 13 C provided acceptable growth; from 5 C to 15 C were best for growth in length; and from 13 C to 20 C were optimal for increase in dry weight. Washington Department of Natural Resources (1984) guidelines for Nori culture lists a temperature range of 6 C to 18 C for this species. A temperature range of 7 to 15 C was listed for Nori by Freeman (1985). Actual growth rates show site variance depending on various conditions. Some species thrive only in small, narrowly defined areas.

Salinity requirements for sea vegetable culture are species specific. Kelp generally require water of high salinity. Porphyra prefer water slightly less saline than open ocean (Freeman, 1985). Washington Department of Natural Resources suggests a range in salinity of 24 to 32 ppt for Porphyra culture.

Macrocystis and Laminaria require wave action for proper growth. Currents of 20 cm/sec or more are desired. However, when currents exceed 80 cm/sec (1.5 knots), problems with anchoring culture apparatus arise (Mumford and Melvin, 1983). For small scale operations, it is advantageous to choose a protected site; for large scale farms of 500 to 1,000 hectares, open ocean conditions are best where stronger waves, wind, and currents provide better growth. For Porphyra, Washington Department of Natural Resources guidelines (1984) list current requirements of less than 2 knots and less than one foot waves to allow work. Current requirements should allow nutrient levels to be maintained at high levels. Optimal levels of nitrogen for Laminaria culture are 7 to 14 um/l. At 3.5 um/l or less, artificial fertilization is necessary (Mumford and Melvin, 1983).
Washington Department of Natural Resources guidelines (1984) require that no nutrient drop be detectable at the culture site.

Water depth requirements for Laminaria farming are 3 to 30 meters. Depths of five to fifteen meters facilitate construction (Mumford and Melvin, 1983). Depths from 18 to 60 feet are recommended for Nori farms by Washington Department of Natural Resources (1984).

Substrate requirements of relatively smooth bottoms, mud to gravel with no cobble, are recommended to facilitate anchoring culture apparatus.

Pests and disease organisms cause a major concern in algae culture. Fungal, viral, and bacterial diseases have been discovered in Laminaria and Porphyra culture and epiphytic growth of various organisms is a problem (Neish, 1979). Guidelines established by the Washington Department of Natural Resources (1984) spell out standard

procedures for combating these problems in Nori culture. Grazing by gastropods on cultured seaweed may be a problem (Saito, 1979). Offering alternate food sources or enclosure in synthetic cages have been tried for protection.

Sea vegetables are similar to shellfish in that they should be grown only in pollution free areas. Kelp concentrates heavy metals such as copper, zinc, arsenic, and mercury (Druehl, 1987) potentially rendering it unsafe for human consumption.

PARALYTIC SHELLFISH POISONING

Alaskan waters are periodically subject to natural dinoflagellate plankton blooms which may result in toxin concentrations in bivalve shellfish tissue. Species involved include clams, oysters, geoducks, mussels, scallops and related species. These toxins are known as paralytic shellfish poisoning (PSP), and human consumption of bivalve shellfish containing significant levels of PSP toxin can result in a potentially serious illness that can result in death.

All outbreaks of PSP in the North Pacific are caused by the organism belonging to the dinoflagellate genus Gonyaulax (Nishitani and Chew, 1984). Gonyaulax species are common members of the marine phytoplankton community. Under normal conditions, their abundance is usually insufficiently high to create a problem with PSP; however, when favorable conditions arise (recent fresh water runoff, water column stability, increased water temperature, low winds, and sunlight) these dinoflagellates can multiply very rapidly and cause a bloom, fostering PSP toxin concentration in shellfish.

Saxitoxin was the first toxin identified from PSP outbreaks, named after the Alaskan butter clam (Saxidomus giganteus) from which it was isolated. Since then about 15 different toxins have been identified as causing PSP. PSP toxins affect humans and other animals by paralyzing their nervous system when consumed, causing loss of critical body functions. Human illness is characterized by mild to severe symptoms occurring a few minutes to several hours after consumption of contaminated shellfish. Most commonly, nausea, vomiting, and numbness or tingling around lips and tongue will develop. If a significant amount of toxins are ingested, and prompt medical attention is not received, death may result from respiratory failure.

Presence of PSP toxins in shellfish cannot be detected by any simple method because these toxins do not alter the appearance, smell, or taste of contaminated shellfish. Since PSP toxins are not affected by heat, cooking shellfish will only slightly reduce toxins present. Freezing also has no significant effect on toxin levels.

PSP dangers in Alaskan waters have been known to local Alaskan Natives for centuries. The earliest recorded PSP episodes in Alaska date back to 1799, when four of Capital George Vancouver's men consumed contaminated mussels, resulting in three intoxications and one death. A short time later, Baranof lost 100 men after they ate a meal of mussels harvested in Peril Straits. From 1799 through 1982, 160 cases of PSP have been reported in Alaska resulting in 103 deaths. Today, PSP intoxications continue to occur sporadically throughout Alaska.

Dinoflagellate plankton blooms which contain PSP toxins are not uniformly distributed in marine waters. The effects of tides, currents, water temperature, winds and chemical factors tend to concentrate organisms in relatively restricted areas, but this cannot be predicted. Although certain environmental factors such as water temperature, salinity, sunlight, nutrient concentration, and stability of the water column are known to stimulate growth of dinoflagellates, the particular combinations of factors resulting in a bloom are not completely understood. Consequently, all beaches are at risk and no simple test can determine safety of a harvest area.

Inshore protected waters and open coastal locales demonstrate different patterns in their rate of PSP incidence. Open coastal waters are less frequently associated with high levels of PSP, but when they do occur they are very widespread. These events suggest correlation with El Nino, an offshore wind present for several days or weeks, and accompanied by an influx of warm stratified waters frequently stretching from California to Alaska. (Nishitani, personal communication to Guy Oliver 2/26/88). Research conducted by Nishitani and Chew shows that one Gonyaulax species which exhibits signs of vertical migra-

tion varies with the degree of vertical stability of water. When water is thermally stratified, they are concentrated during the day from 0.5 to 3 meters and at night from 4-7 meters. When water is mixed by wind driven turbulence or by strong tidal currents, vertical spread and depth of migration are more variable.

Although bivalve shellfish such as clams, oysters, geoducks, and mussels are not usually physically affected by ingestion of the plankton, PSP toxins are retained in shellfish tissues. Eventually, the bivalve is able to purge toxins through elimination. Different species of shellfish concentrate PSP in different parts of their bodies and retain it within their tissues for differing periods. Mussels accumulate PSP rapidly and after the bloom subsides they naturally cleanse their tissue of toxin in a few days to a few weeks. In contrast, butter clams are reputed to retain toxins at high levels for up to 3 years. Clam siphons contain the highest values (as high as 22,000 units) while adductor muscles collected from Kodiak scallops have never been higher than 80 units even when other parts of the animal show high levels.

Different PSP toxins have differing toxicity and some shellfish have evolved physiological mechanisms to minimize the toxic effect upon themselves. Littleneck clams appear to utilize an enzymatic process to change higher level toxins to lower level toxins. Butter clams may be doing the reverse. Preliminary work by John Sullivan suggests they convert lower level toxins into saxitoxin, which has greater toxicity, and then shunt this to the tip of the siphon. In doing so, the clam may be using PSP toxins as an anti-predator device.

Physiological and behavioral mechanisms of various shellfish species determine how toxic they may become. When oysters encounter Gonyaulax concentrations of about 20 cells per ml. they decrease their pumping rate. If the concentration continues to increase they will stop pumping and feeding entirely. If the level of Gonyaulax remains high the oysters will remain anaerobic for up to 7-10 days, after which they are forced to start feeding again. In contrast, mussels continue to feed regardless of Gonyaulax population level. This behavioral mechanism explains why during a Gonyaulax bloom oysters initially show an increase in levels of several hundred units and then plateau for 7-10 days after which PSP units rapidly increase into thousands. Mussels comparatively show no such tendency to plateau, so that PSP levels continue to rise to a peak.

Predicting PSP potential for a particular site is difficult. Three measures which are useful are: 1) monitor PSP levels in mussels on a weekly or semi-weekly basis, 2) quantify the number of cysts in upper sediments, and 3) obtain and review 3-5 years of oceanographic data on the site to determine frequency of conditions conducive to Gonyaulax blooms. Even if all three of these methods are utilized, it does not guarantee that PSP problems will not occur. Nishitani is not certain that quantifying cyst numbers in upper sediments will accurately predict potential for PSP outbreaks in a given area, and consequently may not be a reliable method for determining a potential shellfish growing site.

Some concern exists that shellfish mariculture operations may actually contribute to blooms of PSP producing organisms, especially in a bay with limited circulation and slow nutrient replenishment. In this situation, rafts used for culturing could further reduce circulation, resulting in a stratified water column, and shellfish feces and pseudofeces could act as a source of nutrients.

PSP awareness has spread throughout the world because it is a world wide phenomenon and has resulted in increased numbers of reported cases. There are indications that blooms of PSP causing organisms are occurring more frequently. This pattern is repeated in El Nino events. Since 1972, El Nino events have been occurring at a faster rate than from the 1930's to the 1970's. Whether this is a cyclic phenomenon or a result of the greenhouse effect remains open to further study.

Concerns regarding consumption of shellfish containing PSP toxins are critical because of: 1) inaccurate predictability of occurrence of plankton blooms within a given area, 2) in-

ability to detect the presence of PSP toxins in shellfish without laboratory testing, and 3) potency of the toxins, which directly affect human nervous systems and can be life threatening without medical attention. Therefore, strict measures must be observed to assure that only bivalve shellfish with minimal levels of toxins are marketed.

Monitoring programs are necessary to protect public health from possible rapid proliferation of dinoflagellates, and to promote and protect the shellfish industry. The U.S. Food and Drug Administration has established a maximum level of 80 micrograms of PSP per 100 grams of shellfish meat as the allowable limit for shellfish marketed for human consumption.

In most places, PSP is regarded as a seasonal environmental problem. Washington state and British Columbia provincial governments routinely monitor shellfish sites for PSP levels, and have been able to adequately characterize seasonality of potential outbreaks. This allows commercial producers to ship their product without sampling their lots from late fall through early spring, and implement a progressively more stringent testing regime as the potential for PSP increase occurs.

In some areas, DEC requires every lot of shellfish to be tested for PSP prior to being released for distribution or sale. Data taken in Alaska suggest highest PSP levels from April through late July or early August.

Because dinoflagellate blooms can develop rapidly, dry storage of shellfish is required in most areas prior to marketing, while PSP levels are tested at DEC's Laboratory in Palmer.

A dry storage facility must protect the shellfish from all forms of contamination, including saltwater, while the farmer awaits PSP test results. Refrigerated storage or the equivalent is required for holding during the waiting period.

Before gaining approval as a shellstock shipper, a PSP sampling plan is developed for the operation by DEC. Plans require that the shellstock shipper notify local DEC personnel at least one week in advance of any sale to give the Palmer lab ample time to prepare for tests. Prior to the sale, DEC personnel or the farmer obtain official samples of mature shellfish which are then sent to the Palmer lab. Shellfish held in dry storage are not released for sale until the PSP sampling procedure is completed and satisfactory results are obtained. The farmer is responsible for all costs involved in transporting the samples to Palmer. At the present time, PSP test results of shellfish lots are available within 24 hours of sampling.

PSP test results contained in Table No. 2 were taken from 5 farms in the study area. As previously mentioned, the number of results are insufficient to develop a reliable data base. However, it does show variability between farms in the same general geographic area.

Table 2-1 PSP DATA FROM FARM SITES IN THE STUDY AREA*

Farm site #1 (on map)

Date	Species	Concentration
8/82	Mussels	less than 40
	Bent Nose Clams	61
	Little Neck Clams	less than 40
5/83 - 10/83	Mussels	47 - 60
	Butter Clams	less than 32
	Oysters	32 - 39
4/84 - 7/84	Mussels	39 - 111
	Butter Clams	33 - 63
	Oysters	30 - 67
4/85	Oysters	30 - 33
6/86	Oysters	31
6/87 - 12/87	Oysters	30 - 59
	Butter Clams	121 - 279
1/88	Oysters	less than 34

Farm Site #2 (on map)

Date	Species	Concentration
6/82 - 7/82	Mussels	125 - 268
	Butter Clams	56 - 292
	Oysters	40 - 52
4/83 - 11/83	Mussels	32 - 1989
	Butter Clams	32 - 670
	Oysters	32 - 546
11/84	Oysters	32 - 35
10/85 - 12/85	Oysters	30 - 33
	Clams	36 - 48
1/86 - 10/86	Oysters	30 - 33

Farm Site #3 (on map)

Date	Species	Concentration
5/83	Mussels	61 - 133
	Little Neck Clams	152
	Butter Clams	32
10/86	Oysters	less than 30

Farm Site #9 (on map)

Date	Species	Concentration
2/86	Mussels	32
	Butter Clams	169
	Little Neck Clams	less than 32
7/87 - 8/87	Mussels	32 - 67
2/88	Mussels	less than 30
	Butter Clams	97

Farm Site #11 (on map)

Date	Species	Concentration
7/87 - 8/87	Mussels	32 - 88
	Butter Clams	33 - 49
	Little Neck Clams	less than 32

* Numbers represent micrograms per 100 grams of shellfish meat.

Maximum allowable level of PSP for human consumption is 80 micrograms per 100 grams of meat.

Numbers were rounded off to the nearest whole number for easier reading.

CULTIVATION

Stages Of Culture And Appropriate Technology

Organism types currently being considered likely candidates for mariculture in Alaska include the Pacific oyster, blue mussel, weathervane scallop, and various seaweed species. The culture of purple hinged rock scallop, geoduck (Panope generosa), and pinto abalone (Haliotis kamshatkana) may eventually be feasible.

Kinne (1970, in Mason, 1983) classifies shellfish culture into four classes: 1) maintenance (keeping animals alive without significant growth), 2) raising (fattening young adults), 3) rearing (bringing up early stages, e.g., fertilized eggs and larvae), and 4) breeding (production and raising offspring). Alaska oyster and mussel culture currently consists of the raising stage. Scallop culture is in the experimental collecting larvae for raising stage.

Mumford and Melvin (1983) classify seaweed culture into three stages: 1) enhancement (spread of desirable species in natural beds), 2) semi-artificial culture (control over primary stages of plant development but not of seedstocks), and 3) artificial culture (provision of artificial substrates with seedstocks and all stages of plant development under control). Seaweed culture is in the experimental stage. Semi-artificial culture of M.integrifolia and L. groenlandica with maintenance activities is occurring in the herring roe-on-kelp fisheries.

Techniques are discussed below. Additional description of successful techniques is necessarily based on activities occurring in other states or countries, which may or may not prove to be suitable in Alaska. Those discussed below have been selected because they appear likely to be adaptable to Alaskan conditions.

Some culture stages are carried out successfully only in laboratories or greenhouse hatcheries. Early stage seaweed culture occurs in laboratories or greenhouse operations. Use of laboratories or greenhouses for early stage culture of oysters and mussels ensures a stable supply of seed or spat. Where natural sets are predictable, devices are used in water to collect floating shellfish seed or spat. In Alaska, experimentation is proceeding with collection of scallops and mussels; oyster spat is necessarily imported because water temperatures are too low for local spawning by the Japanese oyster. Laboratory experimentation is also proceeding for Macrocystis culture.

Shellfish larvae may be cultured via one technique to a certain stage and then transferred to another area or structure for intermediate culture or full growth to harvest. Scallops and oysters may be cultured via hanging culture to a certain size, then placed on the bottom for later growth. They may be moved at various stages of growth from bottom areas to different tidal ranges or predator situations to maximize growth and survival. Scallops and oysters are often transferred to structures where they are separated as individuals (e.g., lantern nets or cages) for specialized markets.

Techniques and Facilities for Shellfish Culture

Scallop spat collection is being pursued experimentally near Kodiak Island (Kaill, in prep.) and experimentation in the Yakutat, Ketchikan, and Tenakee Springs areas is planned. Shellfish culture can be described in five stages: 1) seed collection, 2) rearing of early developmental stages, 3) intermediate culture, 4) rearing to marketable size, and 5) harvest and handling.

Various techniques have been developed to successfully culture three shellfish species

with the highest potential for Alaska. The following description is generalized, but innovation of new techniques may occur under specific site conditions. Floating structures, intertidal zone structures, or natural or modified sea bottom are used for the first four stages of culture. Floating structures are used to collect spat or seed in the water column. Seed can be harvested after it has settled by using rakes, shovels, or dredges. Early developmental stages are reared on various structures including trays, nets, or ropes suspended from floating rafts or longlines; racks or poles in intertidal zones, submerged racks or trays, or without structures by placing seed directly on bottom substrates at suitable tidal levels. Transferring animals of a certain size to different structures for intermediate stages of growth is a fairly standard technique in scallop culture in other areas. This technique may be used in oyster culture to grow individual oysters for the oyster-on-thehalf-shell market. Similar floating structures (rafts or longlines) are generally used for intermediate culture, but animals are placed in baskets or containerized nets (i.e., pearl nets or lantern nets) rather than on lines, or collectively in nets, so they don't attach to one another or bite each other with their shells. All three species are also sown on the bottom when they reach sufficient size. Rearing to marketable size occurs either in the same location as early rearing or where intermediate culture occurs. Types of structures used for each culture stage and potential impacts of structures and culture techniques are described below.

Shellfish are generally harvested by boat in floating culture situations. Harvest from intertidal structures, such as poles or racks, may require truck or tractor access, and harvest from subtidal beds may occur by dredging or by use of divers. The three species can have specialized requirements for immediate handling after harvest that also requires intertidal zone use. Oysters grown in suspended culture develop brittle shells and also have adductor muscles too weak to keep the shell closed during storage and transport. They are often laid in intertidal zones for several days to harden. Mussels grown in suspended culture also need to be conditioned to keep their shells closed by storage in the intertidal zone if a longer shelf life is desired. All shellfish are able to clean themselves of impurities if they are provided with a clean water source for an extended time period. To accomplish this in some areas, harvest is followed by moving the animals to a clean water container for washing with a continuous flow of water for several days. In areas where water is polluted by sewage, a different process of depuration is required. Shellfish are held in disinfected water before being certified as fit for human consumption.

Requirements for upland support facilities vary, depending on operation size and type of facilities used for various culture stages. Storage sheds and caretaker residence facilities have often been included in proposed oyster farms in Etolin Island Study Area. It can be anticipated that upland facilities will generally be required as full scale production and future expansion occurs at successful sites.

Culture Techniques and Facilities for Seaweed Culture

Seaweed culture has only recently been legalized in Alaska so no sea vegetable mariculture operations exist in the study area. Locations within the study area may have considerable potential for this activity. Seaweed culture reduces impact on native stocks if it should become desirable to harvest them commercially. Seaweed culture is extensive in some countries, most notably Japan, and experimentation and pilot projects have been carried out in California, Washington, and British Columbia. These efforts have been directed toward enhancing native seaweed stocks (North, 1973) or at creating new stands (Bourne, 1987; Washington DNR, 1987) to sustain commercial harvests for a variety of purposes. Seaweed culture consists of three stages: 1) seed or spore collection, 2) cultivation of early developmental stages, and 3) growth to harvestable size or maturity.

Specific techniques have been developed to enhance natural stocks or to enhance habitat

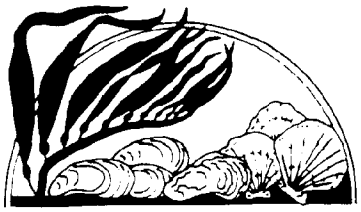
for natural stocks, but none have been tried on a large scale in Alaska. In the first stage of culture, reproductive portions of mature plants are gathered from either natural or cultured stock by divers or from boats. Induction of spore release and culture of early developmental stages occurs in the laboratory for the three species which are most likely candidates for mariculture in Alaska. Techniques for culture of both Macrocystis integrifolia and Laminaria groenlandica have been successful in both Alaska and British Columbia. Experimental growth of Laminaria occurred in Auke Bay (Calvin and Ellis, 1976) and experimental maturation of Macrocystis is being attempted in the Sitka area during 1988 and 1989 (Steckoll, 1987). Immediate application of Macrocystis culture is probably creation of stocks in Prince William Sound (outside the natural range of the species) in close proximity to existing herring roe-on-kelp fishery.

No Nori culture has been attempted in Alaska, but culture techniques for species of Nori similar to those growing in Alaska have been standardized in Japan (Lindstrom, 1987). Importation of Nori on nets from Japan and maturation or harvest has been successful in Washington (Washington DNR, 1987). Nori seed growth occurs in a greenhouse or hatchery, but nets can be seeded either indoors or outdoors.

Because early stages of seaweed cultivation generally occur in the laboratory, requirement for structures is limited to the grow-out phase. Seaweeds are generally grown on nets or ropes attached to floating frames, rafts or longlines. Nori is cultured intertidally in Japan with nets or ropes suspended from poles sunk into substrate. Enhancement techniques have included: 1) placement of artificial substrates on the bottom, 2) transplanting mother plants, 3) sowing seed from boats in areas of suitable habitat, 4) weeding undesirable species, and 5) blasting reefs to create suitable substrates.

To rehabilitate former kelp stands off the California coast, plant transplantation attached to plastic rings and glued to rocky substrates with epoxy, and sowing young plants by pouring concentrated solutions down a hose from a boat have been very successful techniques (North, 1973). Japan has an extensive program of marine habitat enhancement, which includes placement of rocks or substrate blocks with large, relatively horizontal surfaces for attachment. Holdfast supports, seeded with spores, are used in conjunction with structures in areas with high energy waves. Blasting has been employed in Japan following a phenomenon termed isoyake which results in large areas of rocky bottom converted from productive seaweed to calcareous algae. Blasting provides new surface areas which permit successful sowing or transplantation of Laminaria (Saito, 1979). Substrate blocks and rocks are also cleaned periodically by blasting, air drying or coating concrete blocks with a new layer, or by use of high pressure hoses (Mottet, 1981).

Seaweed harvesting is accomplished by divers or manually from boats. In California, harvest has been mechanized using a boat with a cutting edge held a fixed distance below the surface, and a conveyor belt transfer mechanism. Beach areas are sometimes used for seaweed drying, but in Southeast Alaska, drying sheds may be required if on site drying is to occur.



Etolin Island Area

Mariculture Pilot Project

CHAPTER 3

Site Suitability

Chapter 3

SITE SUITABILITY

CHARACTERISTICS OF THE STUDY AREA

Several islands and island groups in the Alexander Archipelago portion of Southeast Alaska comprise the study area. An irregular shoreline of the archipelago produces many marine areas enclosed or semi-enclosed by land which may be suitable for mariculture. Terrestrial and marine factors influence the area's mariculture capability.

Topography

Topography can greatly influence local weather patterns by intercepting and channelling winds, influencing the amount and form of precipitation (freshwater runoff), and creating micro climates. Topography can influence the pattern and amount of solar radiation striking the ocean surface. These effects have important implications for mariculture.

Etolin and Deer Islands are located within the Coastal Foothills physiographic province of Alaska; the Blashke and Kashevarof Island groups are within the Kupreanof Lowlands province. These islands were formed by uplift adjacent to north-south trending faults, one of which extends up Clarence Strait. Topography of the study area has been shaped by glaciers which, at their greatest extent, covered nearly all of the Alexander Archipelago and extended into the ocean as a huge ice shelf. The Coastal Foothills physiographic province, which includes Etolin and Deer Islands, are a westward extension of the precipitous Boundary Ranges of mainland to the east. Blocks of mountains are separated by flat-floored valleys and straits. Mountain tops have been rounded as a result of being overridden by glaciers. Lower portions of stream valleys were drowned as glaciers melted, receded and inlets and harbors were formed. Streams are generally less than 10 miles long, with sedimentary deltas formed at stream mouths. Lakes are abundant on Etolin Island.

The Kupreanof Lowlands province is characterized by areas of lower relief (300-500 feet) and rolling terrain. Glacial features are present, with freshwater drainages following depressions carved by the glaciers. No well-developed stream systems exist on either the Blashke or Kashevarof Islands; some runoff occurs through muskegs which have developed in depressions.

Islands are interspersed along a broad, shallow ocean trough extending from the mainland coastline to the continental shelf edge. Sedimentary deposits resulted from glacial advance and retreat, often in the form of incomplete shallow sills across mouths of inlets and riverine deposits. The Stikine River delta to the northeast of the study area is extensive. Clarence Strait, Stikine Strait, and Ernest Sound are deep channels, while shallow, rocky areas are characteristic around Blashke and Kashevarof Islands and areas offshore of southeastern and southwestern Etolin Island. Snow Passage, Kashevarof Passage, and Zimovia Straits are relatively narrow waterways with shoals and shallow rocks.

Climate

The climate of the Alexander Archipelago is primarily maritime. However, continental climatic conditions may influence areas in

close proximity to large mainland river drainages, such as that of the Stikine River, which extend into the interior. Northeastern and eastern portions of the Etolin Island area likely receive some influence from the Stikine River and mainland weather patterns. Maritime climatic conditions result in a relatively narrow range of cool daily air temperatures and low variability between summer and winter. On a regional basis, temperatures from 40's to mid 60's can be expected in summer, and temperatures in high teens to low 40's can be expected in winter. However, it must be emphasized that due to considerable regional topographic variation, temperatures vary widely, depending on local influences.

No weather stations exist within the study area. Rainfall at nearby Coffman Cove averages 81" per year, which includes 56" of snow. Further description is necessarily generalized to provide information on the type of considerations which may determine weather patterns at a specific site.

Although temperature and precipitation patterns are difficult to summarize and predict for any given site in Southeast Alaska, global weather patterns which determine them can be described. The following is a general description derived from Wallen and Hood (1971) and Selkregg (1975). Three large pressure systems, Aleutian Low, Interior/Arctic high, and North Pacific High interact on a seasonal basis. Interactions of Aleutian Low and Interior High bring warm moist air from the south and southeast in winter which results in precipitation as the air is forced to move up over mountains or colder air is encountered. Amount of precipitation which falls and whether it falls as snow or rain depends on air temperatures which result from the location of the Arctic Front as well as elevational and latitudinal influences. In general and on average, southern Southeast Alaska has milder temperatures, and consequently lower or more intermittent precipitation and less snow accumulation. However, this pattern is not always present on an annual basis. Also, because of the effect of elevation as moist air is forced upward, more precipitation falls on windward slopes of mountains than on leeward sides.

During summers, interactions between continental Interior/Arctic High and a marine low pressure system to the south in the North Pacific result in variable conditions. When the marine system dominates, winds are from the west and precipitation is high; when the continental system dominates, winds are from the northwest or north and conditions are warmer and drier.

During all seasons except summer, the region lies within the path of major storm tracks from the Gulf of Alaska. During winter, the often stationary Interior High also diverts storms towards Southeast Alaska from further west. Storms are most frequent and precipitation is highest during the period of November through January as the Aleutian Low moves southward into the region, bringing a steady onslaught of high-velocity air masses saturated with moisture from the south-southeast.

Hydrology

Freshwater drainage dynamics are important because variations in freshwater inputs to ocean water can modify salinity and temperature of seawater, introduce sediment, pollutants, and nutrients, and drive circulation patterns under some conditions. The amount of freshwater input depends on the size of drainage areas of streams feeding into an embayment, and seasonal climatic patterns, particularly precipitation patterns. If wind and current patterns carry fresh or brackish water plumes into adjacent basins, freshwater flows may influence several water bodies.

In general, nonglaciated watersheds on the Alexander Archipelago exhibit a small peak flow period in late spring or early summer following snowmelt and a large peak flow in fall during the stormy, rainiest period.

Low flow conditions occur during summer following snowmelt and in winter as precipitation accumulates in the form of snow at higher elevations. Higher elevation drainages accumulate more snow which melts over a longer period, extending periods of higher

summer flows. If lakes are present in a watershed, they act as a buffer, delaying and moderating both peak and low flows (Wallen and Hood, 1971). James (1956) further characterized Southeast Alaska watersheds as having a combination of steep slopes, heavy precipitation, and limited water holding capacity which results in unstable flow characteristics due to rapid discharge from rainfall intensity and rapid fluctuations between minimum and maximum flows. He noted minor peaks in flow may occur during summer following summer storms, and high runoff events which can occur during winter following rains which fall on frozen, snow covered drainages.

Hydrology of the Stikine River drainage influences the study area. It is one of the largest drainages in the region and one which includes several glaciers at the headwaters of tributary streams. Glacial melt moderates effects of summer low flows from snow melt and maintains stable flows throughout the season, prolonging periods of large volume discharges from Stikine river systems. The Stikine River is a considerable source of suspended sediment, an effect observed by changes in water color some distance beyond the river delta to the south and west. The Stikine River flow influences oceanic current and tidal flows as well.

Oceanography and Estuarine Processes

Bottom sediments, ongoing sedimentary processes, currents, wave action, estuarine circulation patterns, water temperature and salinity patterns, and tidal flushing capacity are important physical oceanographic parameters in mariculture operations. Biological parameters are related to patterns of phytoplankton productivity, seasonal nutrient dynamics, and biological carrying capacity.

Bottom Sediments and Sedimentary Processes

Bottom substrate composition will determine feasibility of bottom culture and of anchoring culture facilities. It is also one factor which will determine the type of benthic community. Bottom composition within the study area varies considerably with local sediment sources. In general, sediments in the Inside Passage are dominated by silt and clay with variable amounts of sand and gravel near localized sediment sources. Glacial activity has carved many steep-walled basins with bedrock walls and smooth, flat, sediment-filled centers.

Suspended sediment loads are of interest to mariculturists because sediment filtered by shellfish can reduce feeding efficiency. Sediment suspended in the water can reduce light penetration and consequently the depth at which phytoplankton can photosynthesize. Glaciers are the major source of inorganic sediments in Southeast Alaska. This could be a factor in the area influenced by runoff from the Stikine River drainage. In the rest of the study area, a major process of ongoing sedimentation is the delta building process of streams. The suspended load reaching estuaries is proportional to stream discharge size which, in turn, depends primarily on the amount of precipitation. Sediment remains suspended in a surface plume of low salinity water until mixing with sea water occurs. During dry periods, suspended sediments may still occur due to resuspension of sediments over tidal flats resulting from tidal action (Sharma, 1979).

In areas of steep topography, runoff may carry sediment directly from landslides and submarine slides may occur, changing sediment distribution.

Currents and Tides

The northward flowing Alaska Current is the major oceanic current in the Southeast Region. Coriolis effect is very pronounced in northern latitudes, causing a deflection of the Alaska Current to the east. During flood tides, regional currents generally flow eastward, northeastward, or northward, while during ebb tides, flow is in opposite directions (Selkregg, 1975).

Tides throughout Southeast Alaska are mixed, semi-diurnal tides of unequal height. When tidal range is large, strong tidal currents are generated during ebb and flow (Selkregg, 1975). Areas with large tidal prisms (basin cross-section) can generate currents of substantial velocities.

Currents in the study area result from interactions between Alaska current and tidal currents as modified by shoreline topography, bathymetry, freshwater flows, and winds. Unique and dynamic localized current patterns result. Shoreline protuberances and islands deflect currents, resulting in areas of back eddies, while narrow passages constrict flows, resulting in falls or rapids at certain tidal stages.

Wave Action

Wave action is an important variable for mariculture, from the standpoint of operation practicality as well as food supply for filter feeders and rocking effects on cultured shellfish. Protection from wind driven waves and turbulence afforded by shoreline topography is site specific. Wave or swell conditions depend largely on weather in the Gulf of Alaska, which from autumn through spring can generate very rough seas.

Circulation Patterns

Bays and coves with freshwater input exhibit estuarine circulation. Estuarine circulation refers to the distribution of a brackish surface layer resulting from freshwater flows into seawater. Rain and rainfall runoff can also form shallow brackish layers over large water bodies. While the entire Inside Passage can technically be considered estuarine under some conditions, each protected body of water exhibits a unique circulation pattern resulting from freshwater influences. Wherever freshwater enters seawater it tends to remain as a top layer because it is less dense than underlying, denser sea water. Water column stratification is quite stable in absence of mixing events. Extent and depth of brackish layers vary with seasonal discharge patterns of streams, amount of freshwater discharge, tide, current, and wind events that act to mix freshwater into seawater.

A rapid increase in the size of a freshwater plume can occur following rapid, heavy rain runoff because the ground has low capacity for absorbing precipitation (e.g., frozen ground, impermeable soils). Some effort has been directed toward studying and describing estuarine circulation patterns in typical fjord-type estuaries in Southeast Alaska, which often have a sill at the mouth. Less effort has been directed at nonglacial estuaries. In fjord-type systems, movement of the brackish layers and more saline layers drive the nutrient distribution patterns, with the lower layer serving as a source of nutrients which are upwelled into the upper layer under certain conditions (Wallen and Hood, 1971).

An ongoing study of Auke Bay, a small, semi-enclosed bay near Juneau, which may be more typical of bays in Etolin Island, has not documented a similar upwelling system (T. Shirley, pers comm.) Auke Bay has a partial sill and one deep channel influence. While currents and tides may bring nutrients into estuaries in the study area it is probable that any upwelling of nutrients is driven by more localized influences such as wind and tidal action which counteract the stratification of brackish water over seawater.

Enclosed areas with little freshwater inflow exist in areas of low relief, within the study area, for example the Blashke Islands. Nutrient conditions within water columns depend on replenishment from oceanic sour-

ces through tidal mixing. Water bodies around the Blashke and Kashevarof Islands exhibit considerable turbulence as Sumner Straight flows meet Stikine River outflows and are deflected southward, mixing with northward flowing Clarence Straight waters. Offshore upwelling areas have been reported in this area. (B. Paust, pers. comm.)

Temperature, Salinity and Oxygen Patterns

Temperature and salinity profiles of the water column is an end result of estuarine and marine processes under a particular incident light regime. Freshwater inputs alter salinity profiles of the upper water column; incident solar energy striking a water surface warms the upper layer. At a certain depth, water temperature and salinity is stable because it is below these influences. Below 100-125 meters in the Inside Passage, conditions of the water mass are a result of oceanic conditions of waters of Gulf of Alaska which enter through Cape Ommaney.

Conditions in the upper water layer exhibit seasonal patterns. They can also fluctuate rapidly in response to localized influences. Wallen and Hood (1971) described the seasonal pattern. In most enclosed embayments in Southeast Alaska, the entire water column is generally well mixed (i.e., no distinct warmer, more brackish layer is maintained) during all seasons except spring and summer. Winds and storms combined with low freshwater input keep water columns mixed during these seasons. As an exception to this generalization, stratification may occur under some conditions: 1) during periods of exceptionally clear fall weather, 2) in enclosed bays with poor circulation, and 3) in very deep fjords with sills.

During spring, sunlight and long day lengths increase surface water temperatures and melt snow increasing freshwater runoff, which is colder than surface saltwater. Waterbodies stratify under these conditions unless winds of sufficient strength and duration cause enough turbulence to mix layers. Periods of stratification may be interspersed with well mixed conditions throughout summer and on into fall depending on fall cloud cover. Typical fall patterns of storms again mixes the water column.

Stratification of the water column can result in anoxic bottom conditions where oceanic flows are restricted and oxygen is eventually depleted by biological activity. Deep, silled glacial fjords or other waterbodies with restricted circulation may exhibit extremely stable stratification. However, according to Wallen and Hood (op. cit.), few estuaries in Alaska are believed to have conditions sufficient to develop anoxic sediments. Conditions of the Gulf of Alaska oceanic waters, which have highest bottom salinities and lowest surface salinities during late summer to early fall, are considered sufficient to displace estuarine bottom waters in Southeast Alaska in absence of sill restrictions. Even waters of silled basins may overturn eventually during winter.

Tidal Flushing

As described above, general patterns of oceanic currents at depth likely displaces bottom water of most Southeast Alaska estuaries at least on an annual basis. The exceptions would be "basins of most extreme geomorphic restriction or most extreme overturn characteristics" or silled basins with further seaward sills (Wallen and Hood, 1971). However, the frequency of flushing will also determine whether anoxic sediments will be formed or persist. Infrequent flushing can still result in the release of anoxic products.

Tidal flushing regime is also important in terms of residence time of nutrients and relatively warm surface water conditions. In some bays, circulation patterns forms gyres. Water entrained in a gyre may warm at the surface and concentrate nutrients. Tidal flushing is extremely difficult to measure or predict and must be evaluated on a site specific basis. The presence of sand or a clean gravel bottom is an indicator of a well-flushed area; silt and sand bottoms indicate the opposite.

Patterns of Phytoplankton Productivity and Nutrient Dynamics

Bivalves such as oysters, mussels, and scallops are filter feeders feeding on plankton, and in some cases, on organic detritus. Phytoplanktons are a major group of producers in the open ocean and many estuaries. In the absence of extensive eelgrass or seaweed beds, they are the major producer group. Their abundance and productivity are key indicators of food availability for mariculture (Else, Paust, and Burns, 1985).

Few studies of primary production patterns have occurred in Southeast Alaska. A major study (Mathieson et al., 1986; 1987) is now under way in Auke Bay in the northern part of the region, focussing on the phytoplankton spring bloom which is hypothesized as the key process in the subsequent success of recruitment of commercially important species of invertebrates and fish in subarctic environments. During three years of study, patterns of blooms have varied. The spring bloom was characterized each year by an initial period of slow but constant growth of phytoplankton, a short period of very rapid growth and period of decline (Ziemann et. al., 1986; 1987). The second year, a secondary bloom with much lower biomass was documented after an interim period. (Ziemann, 1987). In the third year, an extended series of secondary blooms occurred throughout the summer with a final fall bloom (T. Shirley, pers comm.). The pattern of blooms may vary similarly between bays in the study area and on an annual basis. Some Southeast Alaska bays may have patterns of continuous pulses of phytoplankton production rather than distinct blooms (B. Paust, pers. comm.). Patterns of blooms may determine growth patterns and productivity of cultured bivalves.

Extended sampling of phytoplankton concentrations is important to determine feasibility of mariculture because of inherent variability of phytoplankton blooms.

Results of the Auke Bay study (Mathieson et. al., 1987) indicate factors limiting phytoplankton blooms in subarctic estuaries are light levels during spring and fall and nitrogen availability during summer. A period of 3-5 days of exceptionally clear weather in mid-April when day lengths are sufficient, was required to initiate spring bloom. Once nitrogen was depleted by phytoplankton, the bloom ceased and was only reinitiated if a wind event of sufficient strength and duration mixed the highly stratified water column, entraining nutrients which had sedimented to the bottom, thus bringing nitrogen back up into the photic zone.

Although estuaries in the study area cannot be expected to function exactly like Auke Bay, limiting factors are probably similar. These limiting factors have several key implications for culture productivity during spring, summer, and fall:

1. Factors influencing the amount of solar radiation reaching the water column surface (i.e., basin orientation, topography which provides shading, cloud cover) will control initiation of spring phytoplankton blooms. Factors influencing the amount of solar radiation penetrating the water column (i.e., suspended sediment, density of phytoplankton during a bloom) will control depth of spring phytoplankton blooms, which in many cases is the major annual primary productivity event. These factors will similarly influence initiation and depth of photosynthesis by sea vegetables.

2. Factors which influence nitrogen availability in the euphotic zone (i.e., wind mixing, tidal mixing, upwelling phenomena) will influence initiation of secondary blooms, their magnitude, and duration.

Conversely, processes which tend to stratify water columns and increase stability of stratification (e.g., freshwater inputs, protection from winds) will likely reduce nitrogen entrainment, and therefore reduce potential for secondary blooms and sea vegetable photosynthesis.

Detrital sources of nitrogen from land runoff may play a key role in overall nitrogen budget, particularly when decaying salmon carcasses provide a substantial seasonal input.

During late fall and winter, the water column is well mixed, but light levels are too low for phytoplankton blooms and nutrients may be largely bound in detritus. More research is needed on factors which determine food supply and productivity of candidate culture species during this period, particularly roles played by detritus and phytoplankton during periods following the spring bloom. Nicholson (pers. comm.), a permit holder in the study area, has observed good oyster growth during winter at his Blashke Island site when water temperatures rose above 45 degrees F.

Carrying Capacity

Every habitat area has a particular carrying capacity, expressed in terms of maximum number of organisms it can support. For cultured species, food supply is likely the limiting factor, which is, in turn, limited by factors described above. Habitat has a certain carrying capacity for naturally occurring organisms, before any culture is introduced. Typical features of marine and estuarine systems are a dynamic food supply and animal adaptation to the moveable feast provided by currents and tides. Because of these features, carrying capacity is dynamic and very difficult to quantify.

Some attempts have been made to develop a method for estimating carrying capacity for mariculture, but none have taken into account effects on naturally occurring populations if carrying capacity for cultured animals is reached.

In some production areas in Japan, carrying capacity was determined when production levelled off despite increased stocking rates. Sutherland (1986) is attempting to model capacity of a bay in British Columbia to grow good quality oysters based on food supply, food usage, and bay flushing rate, but estimates are still tentative. He described the key variables determining food supply to the site as phytoplankton concentrations and current speeds. Measurements being taken include growth and quality of oysters in "nonimpacted" and potentially intense (impacted) culture areas, bathymetry of the bay, temperature profiles and stratification during different seasons, and near surface currents at different periods of the tides. Rosenberg and Loo (1983) modeled energy flow through a mussel longline culture in western Sweden. They concluded two main interrelated ecological factors limiting the size of mussel cultures are food supply and current speed. However, they described the site as having a very low tidal amplitude of only .1 meter. Increasing the number of longlines that an area could support required both a corresponding increase in current speed and in quantity of food. They noted that theoretical carrying capacity could vary from the one which could be realized due to decreased currents in the center of cultures. Adapting these models to Southeast Alaska will require a consideration of tidal action effects.

RESOURCE USE / INVENTORY

Maps developed for this project are enclosed inside the back cover. Many resources and uses occurring within the study area have been placed on these maps.

The following narrative describes major resources and uses of the study area:

Timber and Timber Harvest

Timber in the study area consists of Sitka spruce, western and mountain hemlock, western red cedar and Alaska yellow cedar. Etolin and Kashevarof islands have a history of approximately 85 sites near beaches being logged by A-frame and tractor prior to 1966.

Recent upland logging began with the Olive Cove Sale which ended in 1981. The Granite Timber Sale of 48 million board feet (MMBF) is being logged and transported to a terminal transfer facility (TTF) in Anita Bay. The Quiet Timber Sale for 11 MMBF was available at the beginning of May 1987. The Vestige Timber Sale in Southwest Cove for .8 MMBF will be offered in 1988. The Bushy Island Sale for 15 MMBF will continue until 1990. A small sale on Middle Island was logged in 1986. 15 MMBF on Deer Island have been offered for contract but no operations have begun.

Mineral and Soils

The Etolin study area is composed of soils with low, moderate and high mass movement hazard ratings. Some relatively young alluvial soils are present in the area. Extensive wetland areas exist throughout Etolin/Kashevarof Island group.

Four mining claims exist and have been filed on Etolin Island, only one is currently active.

Private and State Lands

In the study area, private lands occur only in Olive Cove. The state selected 524 acres in the cove, and in 1983 sold approximately 80 acres as a subdivision with 26 lots. The state retains ownership of the remainder. Five lots will be transferred from state ownership to the University of Alaska as part of a land settlement.

Two small parcels of private land in Olive Cove were patented prior to state selection. The state has proposed a selection near Mosman on Etolin Island which could place additional land in state ownership.

Visual Resources

Etolin/Kashevarof islands can be viewed from Zimovia Strait, Clarence Strait (Alaska Marine Highway and cruise ship routes) and from numerous bays and anchorages used by recreationists.

Cultural, Historical and Archaeological Resources

A number of limited reconnaissance level archaeological surveys have been conducted in the study area. Identified and recorded sites have been added to the State of Alaska's Heritage Resource Survey.

Transportation Systems

Etolin, Bushy and Shrubby islands have road systems extending into various areas for logging purposes. Roads are constructed and maintained under Forest Service management practices.

Major portions of the road system on Etolin Island extend from Anita Bay. The Anita Bay road system does not connect with the Olive Cove road system which is old and begins at a log transfer facility. The U.S. Forest Service may examine the potential of connecting these two road systems. The Anita Bay road system comes within one mile of Quiet Harbor and one-half mile of Kindergarten Bay.

A road system exists on the western half of Bushy Island. The Shrubby Island road system is very old and begins at an old log transfer facility. A transportation plan for Deer Island will be implemented as part of the proposed timber sale.

Road systems will grow to support logging operations. The time frame for road expansion will depend on the economic viability of the timber industry.

Existing oyster sites in the study area are not currently served by a road system. The proposed expansion of the road systems on Etolin Island could serve mariculture operations by augmenting existing water transportation routes with roads across Etolin Island thereby offering farmers an alternative in case of extreme sea or weather conditions.

Anchorages

Coves and protected waters in the study area are used extensively as small boat anchorages. Anchorages vary in size from one or two boats to over 20. Fishing fleets are major users of these anchorages, but dispersed recreational boating and kayaking occur throughout the area.

Watersheds and Fisheries

Forty anadromous fish stream systems exist in the study area. Including all tributaries, approximately one hundred fish streams have been surveyed and catalogued by the ADF&G. An aquaculture facility (hatchery) is located on Burnette Inlet. A steep pass fishway was installed on Navy Creek during the mid-1970's. Twelve mariculture permit sites for oyster farming are currently located in Whaletail Cove, Mosman/Threeway Passage, and the Kashevarof Island group.

Waters of the study area are rich in both species and numbers of fish and shellfish. Salmon, herring, flounder, crab, and shrimp are all harvested.

The Kasheverof Island water bodies are thought to be especially rich in nutrients (B. Paust, per. comm.). Nearby upwellings and the currents of Clarence Straight likely provide a steady source of phytoplankton, algae and other nutrients to this area. South and west Etolin Island benefit from the southwesterly winds and currents.

Extensive kelp beds exist in the study area, notably in the Kashevarof Island group. However, no Macrocystis is found.
The north and east sides of Etolin Island are subject to influence from the Stikine River drainage which also adds significant levels of siltation. Water temperatures are thought to be lower here than surrounding waters due to this influence.

Wildlife

A variety of wildlife is found within the study area including species harvested by area residents: deer, black and brown bear, waterfowl, grouse, beaver, marten, mink, and river otter. Approximately 50 Roosevelt and Rocky Mountain elk were transplanted to Etolin Island in 1987. Deer populations are currently low on Etolin Island.

Approximately 243 bald eagle nests have been located in the study area. Waterfowl, seabirds, and shorebirds concentrate seasonally in protected areas or in areas where food is abundant. Large concentrations of phaloropes have been observed in waters west of Kashevarof Islands during the spring, which may be an indication of nutrient rich upwelling areas. Sea lions and harbor seals are found in waters of the study area. Offshore rocks and rocky beaches are used as

haul out areas. Various whale species are likely to be present in the area, at least occasionally. Sea otters are not present, but are on the west side of Prince of Wales Island and may expand their range in the future.

Fish and Wildlife Harvest

Important commercial and noncommercial fish and wildlife harvests occur in the Etolin Island area. Commercial fishing occurs for: 1) salmon by purse seine, troll and drift net gear, 2) herring, 3) halibut and other bottom fish by longline, 4) Dungeness and Tanner crab by pots, and 5) shrimp by pots and trawl gear. Beaver, mink, land otter, and wolves are trapped along the beach fringe of Etolin Island and other small islands.

Information about the hunting and fishing activities of Southeast Alaska has recently been gathered by the Subsistence Division of ADF&G, in cooperation with the U.S. Forest Service and the University of Alaska. Quantitative harvest data were gathered during the winter of 1988. Study communities included Coffman Cove, Meyers Chuck, Wrangell, Petersburg, Point Baker/Port Protection and Kasaan. These fish and wildlife harvest data, gathered for 1987, are included below.

Table 3-1 Harvest Data Summary for Etolin Island Area

1987 Fish and Wildlife Harvest in Pounds per Capita

	Salmon Fish	Other Inverts	Marine Mammals	Birds	Deer	Other	Plants	Total
Petersburg	45	45	35	6	45	18	7	199
Wrangell	30	42	42	2	21	24	3	164
Coffman Cove	53	56	11	2	60	1	4	186
Whale Pass	41	26	34	1	50	18	3	175
Kasaan	32	32	74	0	40	2	5	185
Meyers Chuck	105	175	52	14	21	37	11	414
Pt. Protection	111	91	47	3	40	3	15	311
Point Baker	89	63	49	5	94	25	14	344

As part of the recent harvest study by ADF&G, maps were developed that indicated areas where fish and wildlife harvest activities have occurred. Most of these maps are in the process of being drafted and will be available in late 1988. However, report-quality maps of Petersburg and Wrangell use areas will be available in mid-August.

Wrangell and Petersburg residents show use of large areas on and around Etolin Island, including virtually all of the shoreline for deer hunting and most nearshore and estuarine areas for fishing and gathering invertebrates. Wrangell residents report use of the area for harvest of shellfish, marine mammals (harbor seal), waterfowl, deer, salmon, and assorted finfish including species such as halibut and rockfish. Petersburg residents report using the area for deer and waterfowl hunting.

Additional information will be available in late 1988 on the relative intensity of use of portions of the Etolin Island area by residents of nearby communities. Maps can be produced that will show relative intensity of use (by percent of a community's households) of the study area or other areas in the region.

Other measures of fish and wildlife harvest and use are available from Division of Subsistence studies, including amounts of household participation in food harvest activities, quantities and types of food distributed among households, harvest technologies, cultural and economic values, seasonality of resource use, and harvest customs and traditions. The Board of Fisheries and Game use this and other information to identify communities that meet criteria for a subsistence priority in the harvest of fish and wildlife. At this time, all communities in the Etolin Island study area have been determined to be rural for the purpose of the state subsistence law. Future decisions by the Boards will determine the species, populations and stocks to which subsistence priorities will apply in these areas.

Subsistence salmon permits are issued for Thoms Place and Olive Cove. In 1986, Wrangell residents obtained 9 permits for Olive Cove and 44 for Thoms Place, and harvested 190 pink salmon and 277 sockeye salmon respectively.

Residents of nearby communities sport fish in the Etolin Island vicinity. A principal day use area by Wrangell residents is located in waters off the north end of Etolin Island. This area is a major marine recreational fishery for the region, based on effort and harvest figures.

Recreation

Dispersed recreation occurs throughout the study area. Two sites have developed recreation facilities. Steamer Bay has a Public Use Cabin operated by the USFS and Kunk Lake has a trail and shelter. Access to recreation sites in the study area is primarily by water. Anchoring, sport hunting, sport fishing, and upland access to freshwater lakes and use of calmer water in extended inlets are the most common activities.

Table 3-2 Recreation Sites and Anchorages in Etolin Island Area.

Identified by the U.S. Forest Service and the Alaska Department of Fish and Game.

Recreation Area	Use
1. King George Bay	Anchorage, used for black bear, deer and furbearers hunting and trapping
2. Kunk Lake	Recreational trail and shelter, anchorage for deer hunting
3. Dog Salmon Creek	Anchorage, used for waterfowl hunting
4. Anita Bay	Anchorage, used for black bear, deer, and furbearers hunting and trapping
5. Starfish Cove	Anchorage
6. Between Olive & Whale T. Cove	Waterfowl hunting
7. Olive Cove	Anchorage, used for black bear, deer and furbearers hunting and trapping.
8. Whale Tail Cove	Wildlife harvest area, anchorage
9. North of Southwest Cove	Anchorage, dispersed recreation
10. Southwest Cove	Anchorage
11. Menefee Inlet	Anchorages, used for deer, black bear, and waterfowl harvest, access to lakes
12. Fishermen's Chuck	Anchorage

Recreation Area	Use
13. Canoe Pass	Anchorage, small watercraft use
14. South Brownson Island	Anchorage
15. Stone Harbor	Anchorage
16. Stone Island	Hunting, beachcombing
17. Eagle Island	Anchorage, hunting, beachcombing
18. Onslow Island	Hunting, beachcombing
19. McHenry Anchoragd	Anchorage
20. McHenry Inlet	Anchorage, used for black bear, deer and furbearers hunting and trapping, access to McHenry Lake
21. Navy Creek	Access to Navy Lake
22. Cannery Pt. Anchorage	Anchorage
23. Burnett Hatchery	Sightseeing
24. Head of Burnett Inlet	Hunting
25. Head of Mosman Inlet	Hunting
26. Mosman Island	Anchorage
27. Three Way Pass	Anchorage, used for black bear, deer, and furbearers hunting and trapping, beachcombing
28. Johnson Cove	Anchorage, access to Streets Lake, (trout/char concentrations), recreation
29. Steamer Bay	Remote USFS cabin & concentrated fish harvest area, anchorages used for black bear, deer, and furbearers hunting and trapping, recreation
30. Kindergarten Bay	Anchorage, used for black bear, deer, and furbearers hunting and trapping, recreation

Recreation Area	Use
31. Quiet Harbor	Anchorage, used for black bear, deer, and furbearers hunting and trapping, recreation
32. Cove east of Quiet	Anchorage
33. Bushy Island	Limited anchorage, deer hunting
34. Between Bushy & Shrubby	Anchorage, used for deer hunting, furbearer trapping and upland bird hunting
35. Ossipee Channel	Limited anchorage
36. W. Shrubby Island	Anchorage
37. Middle & Blashke Island Group	Anchorages
38. Niblack Island	Limited anchorage
39. S. Deer Island	Anchorage
40. Middle Deer Island	Anchorage
41. N. Deer Island	Limited anchorage

ENVIRONMENTAL IMPACTS

Information concerning potential environmental impacts of various mariculture operations likely to occur in the study area is summarized and cross referenced to guidelines for siting and mitigating impacts. Many potential impacts have been noted as concerns. Proper site selection, stringent controls over importation of exotic animals and disease organisms, prohibition of harmful techniques, and the use of appropriate mitigative measures will help the sea farmer avoid significant adverse impacts that have occurred in areas other than Alaska.

Types of areas which should be avoided when siting floating shellfish mariculture facilities are: 1) areas where accumulation of organic sediment on productive benthic communities can be expected, 2) areas where predator or wildlife disturbance are problems, 3) areas with limited flushing and/or poor water circulation, and 4) areas with waste discharges. Sites suitable for development should have adequate upland areas for support facilities and intertidal areas suitable for beaching gear, hardening shellfish, and holding shellfish for PSP testing where impacts to habitat values are minimized. If other aspects of site selection override environmental concerns, a variety of mitigative measures have been developed which may minimize potential impacts.

From the standpoint of reducing conflicts, a good mariculture site for shellfish culture will have the following characteristics: 1) a bottom flushing capacity which will exceed organic sedimentation rates at maximum production, 2) circulation unrestricted by sills or other bathymetric features, 3) upland and intertidal areas of relatively low biological productivity that can be used for support operations, 4) sufficient separation from sensitive or crucial fish and wildlife habitats (e.g., mouths of anadromous fish streams, eelgrass beds, herring spawning areas, shellfish beds), 5) sufficient separation from predator concentration areas, 6) sufficient separation from concentration areas of wildlife species sensitive to human disturbance (e.g., seabird nesting colonies, marine mammal pupping areas), and 7) sufficient separation from sewage outfalls.

Sea vegetable farms result in fewer types of documented impacts. Guidelines for siting and mitigating impacts are cross-referenced to impacts discussions.

The environmental impact of aquatic farm development is examined in this section in two parts: 1) impacts on water quality, and 2) impacts on fish and wildlife. This section is followed by a section on siting guidelines and mitigating measures.

Environmental Aspects of Siting

Recently passed state legislation prohibits aquatic farms or hatcheries from significantly affecting fisheries, wildlife, or their habitats in an adverse manner. Adverse environmental impacts have occurred in some areas of the world when mariculture was poorly sited or permitted to exceed carrying capacity.

Careful selection of mariculture sites can avoid or minimize these adverse impacts. Degradation of habitat quality, particularly water quality, can reduce culture productivity, and in extreme cases, result in massive shellfish culture deaths. Although a variety of mitigative measures can be employed to minimize environmental impacts of a site chosen for overriding logistical or economic reasons, such measures usually add to the cost of operation. Environmental protection goals of regulatory agencies largely overlap economic interests of mariculturists. Clean water, preventing creation of anaerobic sediments below rafts which may result in production of toxic substances, as well as a lack of predator, disease, and parasite problems can ensure sustained productivity. Both regulatory agencies and aquatic farmers have a vested interest in good site selection for immediate benefit and avoidance of future problems.

Subsequent sections describe environmental impacts which have occurred as a result of shellfish mariculture in areas outside Alaska. This discussion provides a basis for developing siting guidelines and recommended mitigative measures for use in Alaska. Such impacts need not occur in Alaska, but they are described to demonstrate potential impacts considered as possible concerns.

Guidelines

Since environmental considerations are just one part of the equation in terms of final site selection and permitting, mitigation may be necessary if impacts cannot be avoided. Both guidelines for avoidance and mitigation are included in the Site Guidelines and Mitigation Measures section of this chapter and cross referenced to each impact discussion.

Factors Influencing Magnitude of Impact

A number of factors determine whether environmental impacts will occur, whether these impacts will be beneficial or adverse, and whether impacts will be significant.

Because mariculture involves an attempt to maximize productivity of a single species amidst an existing complex and diverse marine ecosystem, some alteration of natural regimes can be expected. For example, additional waste products are produced and food that would normally enter the natural food chain goes into culture production. High productivity goals may make elimination of species that compete with or prey upon cultured species desireable to farmers.

Guidelines developed for the project would avoid siting facilities in areas with concentrated populations of predators. If predation problems develop, the guidelines advise nonlethal control measures and use of a variety of design measures to prevent predation. Current ADF&G policies do not condone destruction of predators after the creation of an "attractive nuisance". Similarly, the guidelines advise nonlethal means for control of fouling organisms (i.e. hand-picking from hanging culture facilities). Prospective farmers will be required to identify predator and fouling control measures and unacceptable means will not be approved.

Factors which determine the extent of impact to the natural regime include the type of species cultured (e.g. seaweeds as primary producers vs. bivalve shellfish as filter feeding consumers), size of operation (area occupied and stocking densities), culture techniques, need for upland facilities, and physical and biological characteristics of the waterbody such as: 1) currents and flushing rates (hydrography and hydrology), 2) nutrient dynamics, 3) baseline water quality, 4) existing benthic, pelagic, and terrestrial communities, 5) composition of bottom sediments, and 6) distance from facilities to sensitive habitats.

Size of Operation

Culture operations in Alaska are currently small scale. However, further projections anticipate successful operations will expand at existing sites and into suitable new areas. Larger operations may be necessary to achieve an economy of scale ensuring long term profitability.

Based on review of 12 applications for mariculture facilties on tidelands within the study area, the range in area for proposed farms employing floating oyster culture facilities has been from less than 1 acre to 25 acres. Table 3-3 lists the proposed structures and overall structure size. Review of approximately 40 other permits suggests the size of facilities proposed for other sites in Southeast Alaska, for mussel culture in Kachemak Bay, and for shellfish mariculture in other regions of Alaska are comparable. The areal extent of proposed culture facilities range from 60 sq. ft. for an experimental raft with lantern nets to 100,000 sq. ft. for a log boom enclosing 144 5' x 20' pens. The area requested ranges from 2 acres to 10 acres, with multiple sites proposed in some cases more than one bay. One proposal was modified from a request for a 1200 acre lease to 8 acres

for floating rafts. Longline rearing facilities have also been proposed, with longlines ranging from 15 to 200 feet long, and from 75 to 1600 feet in lineal distance. Upland facilities development could add substantially to the total development area.

For comparison purposes, Table 3-4 summarizes the reported extent of mariculture operations in other areas of the world. High stocking rates can intensify the magnitude of localized environmental impacts where flushing capacity is inadequate. Culture operations could exceed carrying capacity of a given area, in terms of both food available and localized flushing capacity. Carrying capacity is site specific and varies on a seasonal basis.

No specific information is available on stocking rates of oyster farms in the Etolin Island study area. Stocking rates reported from other areas are shown in Table 3-4.

Need for Upland Facilities

Development of upland facilities adjacent to floating structures results in impacts to terrestrial ecosystems. Upland areas are generally cleared. In areas where a gravel source exists, fill may be required for building pads, access roads, or for dock or loading facilities. Timber harvest may occur to provide a source of materials for log raft mariculture facilities or for buildings.

Proposals for upland facilities were included in 4 of 25 oyster culture projects in the study area; in addition, floathomes were proposed for two projects. One proposal included an oyster eyed-larva setting facility. Lack of similar requests for other proposed farms can be attributed to currently small scale experimental projects. Shellfish and seaweed mariculture throughout the world is commonly associated with areas where uplands are already developed. This is particularly true adjacent to small communities where mariculture work is accomplished cooperatively. It appears reasonable to assume that, with the exception of unique circumstances, most mariculturists will eventually require availability of suitable uplands adjacent to their floating facilities for processing, storage, residence, and caretaking. The nature and areal extent of upland facilities will be a major factor in determining their magnitude of impact.

Table 3 - 3 Size of Oyster Farms Proposed in the Etolin Island Study Area

Structures	Minimum Area Extent of Structures	Acres	Area Requested
4-200' long rafts	800'x ?	?	-
V-shaped log boom enclosing rafts	570'x870'x?	?	-
20 20'x35' rafts	14,000	.3	-
24 20'x60' rafts in300'x900' log-boom/pole raft	27,000	.6	-
8 sites: 10 111'x50'rafts	55,500	1.3	20 acres
10 60'x16' rafts in 200'x425' log-boom raft	85,000	1.95	-
20 13'x4' rafts in 425'x200' log-boom raft	85,000	1.95	-
100 5'x20' rafts in 295'x295' log-boom raft	87,025	2	-
72 20'x60' rafts in 200'x436' log-boom raft	87,200	2	2 acres
48 5'x11' rafts in 200'x550' log-boom raft	111,000	2.5	2 acres
variety of structures within 1,000'x550' log-boom raft plus 250'x250' beach storage area	500,000	11.5	-
3200 4'x10' rafts	128,000	2.9	25 acres

Table 3 - 4 Summary of Reported Areal Extent and Stocking Rates of Various Mariculture Operations

	AREA	Culture Method	Areal Extent	Stocking Density	Source
SEAWEED Porphyra spp.	Washington	Nori Net Culture	300-600 net farm to cover 25-40 acres; nets cover 2.5-4.8 acres	-	Washington, DNR, 1987
SCALLOPS Patinopecten yessoensis	Mutsu Bay, Japan	Bottom Culture	Total area: 14% of 665 mi^2 (1660 $km.^2$) bay	Av. 24,000-40,000/acreat max. density	Ventilla, 1982
				24,300/acre recommended density	Ventilla, 1982
	Mutsu Bay Japan	Hanging Culture	Total area: 31% of 665 $mi.^2$ (1660 $km.^2$) bay	40,000/acre at max. density;	Ventilla, 1982
				12,000-14,500/acre recommended	
	Japan	Longline	50-60 m. long in shallow, inshore waters	10,000 shells/ longline	Ventilla, 1982
			100-120 m. long in off-shore waters	20,000 shells/ longline	Ventilla, 1982

Table 3 - 4 (cont'd)

	AREA	Culture Method	Areal Extent	Stocking Density	Source
SCALLOPS Patino pecten yessoensis	Japan	Longline, lantern nets	"Jumbo" system examples: 1) 480 m. long lines, 22.3 acres	-	Ventilla, 1982
			2) 5.6-7.4 acres	40,500-50,500/acre	
			3) 48 100-200 m. lines, 44.5 acres	100 lanterns/line, 16,200/acre; 250 lanterns/line, 405,000/acre	
	Japan Funka Bay	Longline	23 1200 m. lines, 222 acres	56,200/acre	Ventilla, 1982
	Japan	Longline, ear-hanging	100 m. longline	450/m.	Ventilla, 1982
		Longline, lantern nets	100 m. longline	150/m.	Ventilla, 1982
	Tasmania (feasibility study projections)	Longline	8.4 acre lease	225,000/acre seeded 190,500/acre harvested	Cropp, 1983
Patinopecten caurinus	Washington	Longline	50-100 m.	-	Magoon and Vining, 1982
Hinnites multirugosus	Hawaii	?		Approx. 200,000 400,000/acre recommended (5-10 $m.^2$)	Monical, 1979

Table 3-4 (cont'd)

	AREA	Culture Method	Areal Extent	Stocking Density	Source
OYSTERS					
Crassotrea gigas	Trevanen Bay, Vancouver Island, B.C.	Hanging Culture	60% of bay leased, 154 acres total	"minimum diligent useage"=12,000/acre Intense culture = 150,000/acre	Sutherland, 1986
	S.E. Alaska, 1938-60	Bottom Culture	110-227 acres leased	-	Else, 1985
	Japan	Raft	Standard size 120 m. x 10 m.	-	Glude, 1979
		Longline	70-75 m. long		
	Germany	Submerged cage array	Bottom area=approx. 3 $m.^2$	20,000,000 seed/ acre 2,500,000 harvestable oysters/acre	Meixner, 1979
MUSSLES					
Mytius edulis	Riade Arousa, Spain	Raft	10% of surface area used, .07 acres/raft; 2,040 rafts, 143 acres (total)	-	Marino et. al., 1982
	Rhode Island	Raft	60 acres (total)	-	Glude and Chew, 1982
	Maine	Raft	14 acres (total)	-	Glude and Chew, 1982
	Washington	Raft	5 acres (total)	-	Glude and Chew, 1982

Table 3 - 4 (cont'd)

	AREA	Culture Method	Areal Extent	Stocking Density	Source
	China	Raft	50-60 m. long rafts	-	Zhang, 1984
	Prince Edward Island, Nova Scotia	Longline	330' longlines	-	Anonymous, 1986
	Ireland	Longline	40 m. longlines, 5 acre leases	-	Herriott, 1984
	Sweden	Longline	.2 acre farm ($4500\ m.^2$)	-	Rosenberg and Loo, 1983
MUSSLES *Mytitus edulis*	Sweden	Longline	.06 acre farm ($1500\text{-}2000\ m.^2$)	-	Swedish Council for Planning and Coord. of Res., 1985
	Italy	Intertidal Racks	.25 acre plots	-	Korringa, 1979
	Netherlands	Bottom Culture	11-25 acres plots	-	Korringa, 1979

ENVIRONMENTAL IMPACTS, WATER QUALITY

Potential Water Quality Impacts

Mariculture requires clean water. Water quality surrounding culture facilities can be affected by both mariculture activity or other nearby uses or activities. Two key water quality issues associated with mariculture are: 1) changes in water quality caused by mariculture operations, and 2) potential siting conflicts with other uses or activities.

One major concern with mariculture operations is unfavorable changes in water quality and environmental conditions that may develop during normal facility operations. Specific changes may occur including increases in organic deposition under culture rafts, changes in water circulation patterns and changes in water chemistry.

Sedimentation can result as organic matter deposits from wastes, shell fragments, etc. build up on the bottom below culture rafts. The amount of organic matter produced is dependent upon the size of the facility, production level, and environmental factors such as water depth, current velocity, flushing, and bottom topography. Accumulation of wastes and sediments can induce chemical and biological changes in bottom habitat and water columns. Another possible problem resulting from organic sedimentation is a change in the benthic macroinvertebrate (e.g., polycheate worms, snails, insects) community. Species unable to tolerate organic enrichment may disappear, and other more tolerant species become dominant.

Organic enrichment is site specific. Locating culturing facilities in areas with adequate depth and tidal or wind induced flushing will greatly reduce bottom accumulation through greater disperison of wastes. A study of mariculture environmental effects in Puget Sound (Weston 1986) concludes a high probability of solid waste accumulation if less than 15 meters of water is maintained below a mariculture facility. He found most mariculture facilities in Washington State were sited in waters less than 20 meters deep.

In the study area, divers observed only a minimal dusting of sediment under rafts in Canoe Lagoon (A. Grossman, pers. comm.). This site has been used for oyster production since 1983. Water sampling in this area indicated a good tidal exchange even though the lagoon is isolated at low to medium tides. Divers at a proposed oyster farm in Mosman Inlet observed natural sedimentation in the area possibly due to a sill restricting tidal exchange (T.Farris, pers. comm.). Sedimentation may be a problem in similar areas if stocking densities exceed flushing capability.

Mariculture facilities may reduce water circulation in the immediate area of culture facilities. A number of variables can affect flow reduction including flow rate, density of water, enclosure size and type, stocking density, and degree of fouling. Reduced water circulation may result in decreased food availability to parts of the culture structure and increases in sedimentation rate under rafts.

Weston (1986) cites one study which measures a reduction in current velocity amidst culture strings of Pacific oyster in Japan. Velocities were reduced within the raft by 12% to 14% compared to those outside the raft, but 1 meter below the lower end of oyster strings, no consistent effect on current velocity was found (Arakawa et al., 1971). In Hiroshima Bay in 1968, 6000 oyster rafts (9 meters x 18 meters each) acted as a floating breakwater to damp waves and reduce water circulation so the current speed on the shoreward side was only one-seventh or one-eighth of speed on the seaward side. A drop in productivity is attributed to a decline in water quality from changes in water and sediment chemistry (Mottet, 1981). These problems could occur in areas of inadequate flushing or intensive culturing activity.

Water chemistry changes may occur from mariculture facilities. Information on mussel culture indicates the possibility of a net reduction in nutrients (nitrogen and phosphorus) around a culture facility. Studies show 40% of nutrients filtered by mussels are put back into the water column in the form of waste products, 30% are concentrated in growth removed during harvest, and 30% is excreted as feces or pseudofeces (Ackefors and Grip, 1985; Ackerfors and Soedergren, 1985; in Weston, 1986). Weston (1986) reviews potential impacts of waste products on water quality and concludes ammonia is the only water quality parameter of any concern from mussel culture. Concentrations downcurrent from farms would be well below toxic levels for other organisms. In situations of extremely dense and large scale culture, production of nitrogenous wastes are potentially significant.

A majority of unfavorable changes in water quality and environmental conditions can be avoided by properly siting mariculture facilities. Water quality problems would be anticipated only in areas of limited flushing or intensive culturing activity. Field studies rarely have shown organic deposition or any other culture induced water quality change to be a problem at facilities located in well flushed areas.

Potential Water Quality Conflicts

Mariculture facilities can conflict with other uses or activities. It is widely recognized most suitable mariculture sites are also suitable sites for other water-dependent and water-related activities. Because mariculture facilities need pristine water to operate, water quality in areas surrounding mariculture facilities is critical. Some existing activities could have an associated discharge detrimental to cultured organisms.

Sewage discharge from upland development, caretaker facilities associated with a mariculture project, boat traffic, or any other pollution source can lead to operational problems for aquatic farmers. Shellfish are filter feeders and readily concentrate fecal coliform bacteria and heavy metals in their bodies. Aquatic farms proposing to locate near existing subdivisions must be properly sited and separated from the effluent discharge to ensure that ambient water quality at the mariculture site is at levels suitable for that use.

Alaska Water Quality Standards establish levels of allowable fecal coliforms by designated water use. For example, in waters designated for industrial use, allowable levels of fecal coliforms is not to exceed 200 Fecal Coliforms/100 ml based on a minimum of five samples taken over a period of 30 days. Allowable level of fecal coliforms for harvesting and consumption of raw mollusks or other raw aquatic life is 14 FC/100 ml. Conflicts arise when an area has historically been used for something other than mariculture, and the approved level of fecal coliforms has exceeded the mariculture allowance.

ENVIRONMENTAL IMPACTS, FISH AND WILDLIFE

Potential Impacts of Specific Techniques

Anchored Floating Facilities

Anchored floating facilities are the only facility types currently in use or proposed for use for shellfish or seaweed culture in Alaska. In the study area and in other areas of Alaska, oyster farms consist of arrays of trays or nets suspended from rigid raft structures, usually composed of logs, boomsticks, poles, or plastic pipe. Some farms have a log float corral of boomsticks surrounding the raft or tray array. One mussel culture operation is being carried out on similar raft structures in Kachemak Bay. Longline systems, similar to those in use in Japan and other countries, are being used for oyster and scallop spat collection, and rearing experiments have been proposed for mussel and oyster culture.

Potential environmental impacts of floating mariculture facilties have been summarized by Weston (1986) for Puget Sound and potential impacts of nori farms have been summarized by the Washington Department of Natural Resources (1987) Programmatic Environmental Impact Statement. Weston's study of impacts focused primarily on salmon net pen rearing facilities but also on mussel rafts and longlines.

Studies of environmental impacts on shellfish culture include scallop and oyster culture in Japan (Motoda, 1977; Mottet, 1981; Ventilla, 1982; Kafuka, and Ikenoue, 1983; Wakui, 1983), oyster raft culture in British Columbia (Sutherland, 1986); and of mussel culture in Spain (Tenore and Gonzalez, 1976; Olaso, 1979; Iglesius, 1981), along the west coast of Sweden (Dahlbaeck and Gunnarsson, 1981; Mattson and Linden, 1984), and in the White Sea (Golikov and Skarlato, 1979). Weston (op. cit) grouped potential environmental impacts into categories. Categories of impacts relevant to suspended shellfish mariculture (rafts or longlines) are as follows: 1) changes in water circulation, 2) changes in water chemistry, 3) sedimentation beneath culture operations, 4) alteration of phytoplankton biomass and productivity, 5) effects on benthic (bottom dwellers) communities and more mobile invertebrates and fish, 6) introduction of exotic species, 7) disease transmission from cultured to wild animals, and 8) proliferation of bacteria pathogenic to humans. The next four types of impacts are discussed under the Potential Water Quality Impacts Section; the other six are discussed under the section on Potential Impacts to Fish and Wildlife and their habitats. Introductions of exotics, disease transmission, and proliferation of bacteria pathogenic to humans are of concern in all types of mariculture and is discussed in the section on impacts common to all facilities.

Sedimentation

Two types of sediment could potentially occur as a result of suspended shellfish culture: 1) suspended sediment settling out of the water column, and 2) deposition of organic matter from wastes, dead animals, shells, etc. Weston (op cit.) concluded that settling of the suspended load was unlikely in Puget Sound, an area with very low suspended sediment loss, but that sedimentation could be expected to be greater in areas of major riverine inflow, and consequently unsuitable for mariculture due to variable salinity regimes and phytoplankton blooms. This form of sedimentation may be more significant in areas of Alaska where suspended loads of glacial sediments are high. Hemming and Hemming (1984) described siltation of mussels growing on rafts at farms located fairly close to a glacier terminus. Their farm location is a unique situation; Halibut Cove Lagoon is perched slightly above the waterbody into which a glacier empties and the two waterbodies are connected by a narrow opening which develops a tidal rapids. Thus, siltation occurs only under certain tidal conditions when a back-eddy forms.

Deposition of materials underneath rafts or longlines can also be significant in areas where bottom currents are insufficient to disperse them. Mussels, oysters, and scallops filter large volumes of water and excrete feces and pseudofeces (rejected particles which are handled but not ingested). Shell debris and dead animals also drop off suspended structures. While currents can disperse a certain amount of material, Weston (1986) concluded there would be a high probability of solid waste accumulation if less than 15 m. of water was maintained below a mariculture facility. He found that most mariculture facilities were sited in waters of less than 20 m. in depth but that data was lacking on facilities in deeper waters (longlines are often employed in deeper water situations in many areas rather than rafts).

Dahlbaeck and Gunnarsson (1981) reported a sedimentation rate from a mussel raft in Sweden as three times higher than nearby reference stations. Deposition was about 7 kg of dry matter per square meter. According to the Swedish Council for Planning and Coordination of Research (1983), mussel farms in Sweden are usually dimensioned to yield 100 tons of mussels, including shells, and require 1500 to 2000 square meters, the sedimentation of dry matter would amount to about 10 tons and the growth of sediments would be about 10 cm per farming season. A 100 m longline of scallops in Saroma Lake, Japan, was estimated to produce 2.5 tons of excreta per year. The lake which is 160 square kilometers and 20 m deep at the deepest, is reportedly silting up due to restriction of current flow through culture systems and sedimentation from the rafts (Ventilla, 1982). In Hiroshima Bay, Japan, depositon from a 9 x 18 m. oyster raft was estimated to be 40-50 tons (dry weight) annually and 6000 rafts were in the bay (Mottet, 1981).

The potential for sediment buildup on the bottom is highly site-specific. It may occur at shallow Alaska sites where circulation is restricted and tidal flushing does not occur regularly. In the study area, divers observed only a minimal dusting of sediment under rafts in Canoe Lagoon (A. Grossman, pers. comm.). This site has been used for oyster production since 1983. Water sampling in this area indicated a good tidal exchange even though the lagoon is isolated at low to medium tides. Divers at a proposed oyster farm in Mosman Inlet observed natural sedimentation in the area possibly due to a sill restricting tidal exchange (T. Farris, per. comm.). Sedimentation may be a problem in areas like this if stocking densities exceed flushing capability.

Alteration of Phytoplankton

The potential contribution of shellfish culture to phytoplankton blooms (due to recycling of nutrients, particularly nitrogen) was investigated by Weston (op.cit.). Blooms are important to other shellfish mariculturists if the organism responsible for paralytic shellfish poisoning (PSP) is involved. Harmful blooms have been linked to shellfish culture only in extremely intensive culture situations in Japan. In Hiroshima Bay, Japan, Heterosigma blooms occurred for the first time after oyster culture productivity began to decline, and it was shown blooms were accelerated by oxidation of partly decomposed substances from shellfish excrement. In Funka Bay, PSP outbreaks from a Protogonyaulax spp. may have been linked to transfer of infected seed scallops from other areas or to changes in nutrition levels at the bottom of the bay (Mottet, 1981). Siting to avoid sediment accumulation should minimize potential for this impact in Alaska.

Mollusc filter feeding could reduce phytoplankton standing stocks on a localized basis. Imai (1971) documented a reduction of particulate matter of a magnitude of 76-95% after passage through 11 rafts supporting 50,000 to 90,000 oysters each. Reduced phytoplankton stock is a reason to locate large or intensive culture operations, or several culture operations in waterbodies with good circulation and productivity. Effects of tidal action need to be considered in determining carrying capacity of bays for culture operations and separation distances between farms.

Guideline 1b should address this concern.

Effects On Benthic Communities

Should organic sediment accumulate on the bottom below floating mariculture facilities, the major effects would be on benthic animals, those living in or on the sediments. Impact studies have been directed at larger invertebrate animals such as polychaete worms, molluscs, and crustaceans, all important components of prey for important commercial species of bottom feeding fish. Weston (op. cit.) investigated impacts both on the benthic community, organisms living in close contact with sediments (burrowers and sessile filter feeders) and more mobile animals such as crabs, starfish, and fish which are able to exploit food resource provided by organic sedimentation but are not as intimately tied to sediment chemistry effects.

Weston (op cit.) provides an excellent summary of changes in benthic communities expected if sedimentation occurs, from which the following description is taken. The addition of organic matter initially enhances a community; number of species, abundance, and overall biomass increases as a food source and nutrients attracts detritus and filter feeders. However, if additional organic matter is deposited, eventually the number of species that can survive is very low. The few species present are very abundant and biomass is high at this stage of organic enrichment. At higher rates of organic input there is a complete absence of benthic macrofauna, due to absence of oxygen in bottom waters and sediments as water exchange of oxygen decreases and eventually becomes too low to support aerobic organisms. Release of hydrogen sulphide into the water column is toxic to shellfish, and occurs as a by-product of metabolism by anerobic organisms. Development of an anerobic sediment layer also affects organisms that live within sediments (i.e., burrowers) since they also cannot obtain oxygen and are eventually excluded.

In mussel farm effects studies in Sweden, Mattson and Linden (1983, in Weston, op. cit.) observed this progression under a longline and also observed recovery after removal of a mussel culture facility that had been in operation for three years. The benthic community reached stages of low species numbers within 6 months and original species dominant in the community disappeared after 15 months. Six months after removal the bottom was still covered by 20-40 cm of mussel shells and sediments rich in sulphides. Only limited macrobenthic recovery occurred within a year and half. The area of organic enrichment was limited to within 20 m of the culture site. Dahlbaeck and Gunnarsson (1981) also observed an accumulation of sediments rich in sulphides, and a progression towards anerobic sediments.

Intensive raft culture studies have been conducted in the rias of Spain. Two studies (Tenore et. al., 1982; Lopez-Jamar, 1985 in Weston, 1986) documented a benthic community under raft culture dominated by polychaete worms, with species diversity, abundance, and biomass decreasing over time. Ria de Arousa supports an intensive raft culture that covers 10% of the surface area. However, it is very productive due to extensive nutrient rich upwelling and high phytoplankton production. It supports about 2000 rafts and has one of the highest protein yields per unit area on earth. A comparison study of Ria de Muros with less than 100 rafts documented a high diversity and equilibrium assembly on muddy sediments (Tenore et al., 1982).

A study in New Zealand documented decreased diversity in sediments under mussel culture and presence of polychaete worms in contrast to brittle stars, molluscs, and crustaceans in a reference area (Kaspar et al., 1985 in Weston, 1986). Golikov et al. (1979) reported increased biomass and total respiration under mussel culture in the White Sea. He did not provide information on species diversity. Abundance and noted decreased productivity in reference areas was affected by siltation and unfavorable anthropogenic factors.

Sedimentation and resultant chemical changes can affect organisms that burrow into sediments, such as clams. They can continue to obtain oxygen through use of siphons from

water overlaying sediments, but mortality is likely as more sediments accumulate.
Mobile benthic species appear to benefit from all but the last stage of organic enrichment. Romero et. al. (1982) documents a higher density (up to six fold) of crabs under rafts than areas without rafts in Ria de Arousa in northwest Spain. He attributes this to their opportunistic and mobile feeding habits. Other studies in the same area document increases in bottom fish that may benefit from cover provided by shell deposits (Chesney and Iglesias, 1979 in Romero et. al., 1982), higher density and biomass values and denser populations of echinoderms, especially sea stars (Olaso, 1979 in Romero et. al., 1982) under rafts. Weston (1986) cites studies with similar findings in Puget Sound (Pease and Goodwin, unpub.), in New Zealand (Kaspar et. al., 1985), additional studies on Ria de Arosa in Spain (Tenore et. al., 1982; Lopez-Jamar, 1984), and in Sweden (Mattsson and Linden, 1983). Mussels which fall from rafts provide for growth of organisms and attract predators. Epifauna from rafts provides a food source for fish and starfish. Conversely, he cites a study in Japan (Ito and Imai, 1955) which documents an elimination of starfish in Japan in an area of extreme organic enrichment under oyster cultures. Some areas of intensive scallop culture in Japan appear to have reached a maximum capacity for production. Densely stocked areas, such as Lake Saroma and Mutsu Bay, have experienced massive mortality believed to be due, in part, to declining water quality and toxic hydrogen sulfide production from bottom sediments (Motoda, 1977). This form of intensive mariculture developed over many years and can be avoided in Alaska with careful siting and monitoring of bottom conditions as culture intensity increases.

In summary, organic matter accumulation and a typical sequence of benthic changes can be expected under suspended shellfish culture facilities, unless bottom currents are sufficient to disperse the sediment. If accumulation is deep enough and an anerobic sediment layer forms, the benthic community closely tied to life in or on the sediments and oxygen presence will be eliminated. In addition to loss of habitat for a particular species, a decrease in abundance of food items can effect the food chain. In extreme cases, mortalities or toxic affects may occur in more mobile species associated with sediments and the overlying water column. Many site factors influence occurance of adverse environmental impacts. Baseline sediment chemistry and water quality, depth of water beneath the culture, and currents and circulation patterns in the waterbody are key variables determining the rate of accumulation of organic matter. Areal facility extent and stocking rate are also key determinants on impact magnitude.

Guidelines # 1a, 1b, 1c, 8a, 8b and 13c were developed to avoid or minimize adverse impacts to benthic communities as a result of organic sedimentation.

Suspension from Poles

Use of poles or pilings set in an intertidal area is a method of mussel and oyster mariculture utilized in France (Magoon and Vining, 1981) and for net culture of Nori in Japan. Similar techniques are being employed in Washington (Washington DNR, 1987). Use of the intertidal area permits a period of drying which may kill fouling organisms on nets and rearing structures. Bouchot culture of oysters and mussels in France involves attachment of netting or strings directly onto wooden poles. Culture grounds are fairly extensive on a mudflat area and truck access is used to replace pilings or perform various culture techniques. Siltation problems have been encountered due to its location at a river mouth and connection of an extensive pole gridwork with interwoven branches (Korringa, 1979). Other techniques using stakes set in intertidal zones extending 6-8" above the bottom and "umbrella" culture with radiating ropes attached to stakes are described by Magoon and Vining (1981) as suitable for use in Washington. They recommended use of cedar, redwood, creosoted fir, or plastic stakes, and reported PVC structures also worked well. Nori net poles are traditionally bamboo, but a recent use of fiberglass has been innovative.

Pole suspension or pilings result in impacts to the intertidal area. Driving of piles or stakes might require access by heavy equipment and maintenance might require vehicle access. These operations result in compaction of the substrate and loss of benthic habitat. Similar effects on organic matter sedimentation could occur in absence of currents sufficient to disperse sediments.

Guidelines 1b, lc and 13a were developed to avoid or minimize these impacts.

Washington DNR (1987) identified potential significant impacts from Nori farms to include shading of eelgrass or seaweed beds, disruption of salmon migration and herring or smelt spawning, restriction of travel by marine mammals, and disturbance of sensitive bird species in nesting areas and overwintering areas (bald eagles, osprey, herons, trumpeter swans, peregrine falcons, waterfowl.)

Nori is generally farmed where the bottom is covered with loose sediment for ease in anchoring structures. Eelgrass grows on similar bottom types and needs surface light. Nori nets or rafts sited over eelgrass beds could reduce available light for eelgrass, resulting in lower productivity, food chain effects on fish and birds, and loss of substrate stability. Other seaweeds, such as bull kelp (Nereocystis luetkeana) grow attached to rocky substrates and are less likely to be impacted. They would foul and damage Nori culture so the presence of kelp would make the site undesirable.

Structures could disrupt migration of salmon or act as hiding areas for predators on salmon. Herring could spawn on the Nori. Structures offshore of traditional beach spawning areas could alter wave action and change conditions for herring and smelt spawning. No data is available on the impacts of existing Nori farms on salmon because they have been sited in depths greater than 10 feet which avoids areas used by outmigration of young salmonids, but potential for adverse impacts exists (Washington DNR, 1987).

Guidelines 1e, 13a, 13b and 14d were developed to avoid or minimize potential impacts of Nori farming

Intertidal and Submerged Structures

Racks are used in the intertidal area to keep oysters separated for the half-shell trade. In Washington, cut lumber or poles are driven into low intertidal areas as uprights to support shallow trays (Magoon and Vining, 1981). Shallow water racks are used for Japanese oyster culture or fixed to the bottom beyond intertidal range, and also intertidally in France (Glude, 1979). In British Columbia, racks built at different tidal levels are used to transplant oysters between intertidal and submerged conditions at different life stages (Gunn et. al., 1983). A new technique in British Columbia makes use of rebar supports for cedar frames and plastic "pillow" bags with mesh tubing for young oysters. Areas are chosen for exposure to air 1-2 times per month for fouling control (J. Hemming, pers. comm.). In Germany, a submerged tray array has been designed. Trays are perforated plastic in a steel framework which is maintained by use of a barge mounted crane (Glude, 1979; Meixner, 1979).

Potential impacts of this technique are similar as those for pole culture. The racks would also shade areas underneath them.

Guidelines 1b, lc and 13a were developed to avoid or minimize these types of impacts.

Bottom Culture

Oyster bottom culture has occurred historically in Alaska (Else, Paust, and Burns, 1985), but it is not currently practiced. Bottom culture may involve enhancing natural beds of scallops or mussels or in creation of beds of these species or of oysters in areas where they are not growing naturally. Enhancement or creation of sea vegetable beds by placement of artificial substrates could occur, but any effect of localized change to the substrate would be

outweighed by the generally productive nature of sea vegetable bed habitats. Conversely, the specific impact of bottom culturing shellfish on existing benthic communities depends on the following: 1) composition of communities, 2) outcome of competition between natural community residents and cultured species for space and nutrients, and 3) predation rates on cultured species. These types of impacts are impossible to quantify or predict.

Certain measures used elsewhere could result in impacts if permitted in Alaska. Elimination of competitors or predators offers advantages and disadvantages. Measures described in the manual about shellfish growing in Puget Sound include placement of shell, gravel, veneer cuttings, thin plastic sheetings below crushed shell, or gravel to provide a firmer substrate in areas with soft bottoms as well as ploughing sandy bottoms, destroying eelgrass beds by covering them with plastic or roofing, and altering tidal levels through fill. Magoon and Vining (1981), report the pesticide Sevin, which can be lethal to young crabs and other organisms, is used extensively by Washington oyster-growers. Quayle (1969) describes the problem of ghost shrimp which can burrow extensively and soften oyster grounds. Use of heavy equipment or plastic sheeting to crush or suffocate them is recommended. None of these techniques have been proposed in Alaska; they are provided as examples of what is described as acceptable techniques in other areas and to illustrate potential impacts.

In areas other than Alaska where bottom culture is practiced, predators are eliminated by lethal means. In Japan, starfish and sea squirts are removed by either dredging or liming (Ventilla, 1982; Wakui, 1983), fishermen are required to catch and kill a quota of starfish (Mottet, 1979), and oyster drills are collected manually at low tide (Glude and Chew, 1982). Starfish were removed from seeded natural beds of scallops in England (Mason, 1983). Urchins can be a significant kelp predator and efforts for control have included use of quicklime and hammers (North, 1973). However, in Japan, where urchins are eaten, one experiment involved culturing seaweed to fatten urchins, then harvesting them, and eventually establishing a natural system producing both kelp and urchins (Mottet, 1981). Labor intensive means which are not lethal exist to control predators. Use of lime may have negative impacts on nontarget organisms. Dredges have been used to collect seed (Wallace and Reisnes, 1985), transplant animals at certain growth stages to other bottom areas at a different tidal level or to floating culture and to harvest animals. Should this practice be proposed in Alaska, potential for significant adverse impacts is high. The impact of dredges on scallop beds has been a problem in regulating commercial harvests from natural beds, which eventually decline after repeated harvests. Selective harvest of larger scallops is difficult to achieve because selective gear is soon clogged with debris and large animals block escape of smaller animals. Caddy (1973, in MacKenzie, 1979) reports effects of scallop dredging in the Gulf of St. Lawrence include: 1) mortality of younger scallops from mechanical damage during dredging or return to beds, 2) sublethal damage to scallops left in dredge tracks, 3) disturbance and roughening of the bottom, 4) siltation and packing of young scallops with sand or silt, and 5) attraction of predatory fish and crabs to dredge tracks. He documents densities of 3 to 30 times greater inside tracks than outside after dredging. A study in New Zealand (cited in Blackett, 1987) also documents high mortalities of young scallops associated with dredging; beds seeded with scallops at densities of 10/square meter has a survival rate of 20% after 9 months while those which had been dredged has a survival rate of .8%.

Guidelines 1d, 1e and 1f were developed to avoid or minimize these types of impacts.

Intertidal Handling

Use of intertidal areas adjacent to floating facilities is often desirable to hold animals out of water or in conditions where they are exposed to air at least part of the day. Air drying of rafts or nets is also a recommended technique to control many forms of fouling (Else, Paust, and Burns, 1985; Nicholson, 1987). In

Alaska, it can be expected that at a minimum, oysters and mussels will require a period of holding out of the water while awaiting results of PSP tests.

Impacts on intertidal areas depend on the activity, particularly if equipment is used to transport or process shellfish, or if structures are constructed. Compaction of the substrate, pollution, disturbance, and elimination of existing intertidal communities are potential adverse impacts.

Site selection should include the location of intertidal areas with relatively low productivity (i.e., gravel or sand beaches) that can be used for equipment drying and hardening so that impacts to high-value habitats (e.g. vegetated tideflats or sensitive habitats such as shellfish beds) can be avoided.

Guidelines 1f and 1g were developed to minimize these types of impacts.

Fertilization

Fertilization is used to increase nutrient supplies to seaweed cultures (Saito, 1979). A Report from the Swedish Steering Council for Planning and Coordination of Research (1983) described the addition of 90% nitrogen - 10% potassium pellets to Nori farms in Japan and use of 1 kg of fertilizer to produce 3.75 kg of Laminaria. An experiment in California, however, resulted in a finding of no significant differences in growth of either Macrocystis or Porphyra following fertilization (Fei, 1983).

Fertilization may be proposed in Alaska as a technique to increase the nutrient supply in a localized area. Nutrient addition could offset any localized effects of nutrient depletion resulting from culture. As an example, nitrogen, which is generally the limiting nutrient to production in marine systems, will be added. It is possible fertilization could lead to eutrophication, reduction in dissolved oxygen content, and changes in bottom sediment chemistry in areas of restricted water flows and poor circulation.

Guideline 1b should minimize this type of impact should fertilization ever be proposed.

Potential Impacts Common to all Facilities

Introduction of Exotics

The introduction of exotic species is of possible concern from the standpoint of competition with native species and the possibility of introducing associated organisms that may have negative effects on native species. The ADF&G has adopted a conservative policy toward introductions which should avoid these negative effects. Currently, the only species that can legally be imported into Alaska for use in mariculture is Japanese oyster (Crassotrea gigas) in spat form from approved sources. Due to lack of hatchery and laboratory facilities in Alaska for early stages of shellfish and seaweeds culture, it is likely mariculturists will be interested in importing seedstocks of exotic species and of species native to Alaska. Nori in particular would have to be cultured as an exotic species. Otherwise, development of techniques adapted to indigenous species would take at least 10 years. This situation has prompted a continuous effort to develop a plant mariculture policy for Alaska. A committee of pathologists, botanists, invertebrate zoologists, and prospective mariculturists is working to ensure a responsible approach. (M. Kaill, ADF&G)

Under current policy, potential for spread of exotics is extremely low. Japanese oyster should not compete with native species if accidentally released into the wild, because it has never reproduced under Alaskan conditions. However, Nicholson (1987) reports observing some gonadal development of cultured oysters within the study area after unusual conditions of high water temperatures reached 70 degrees for 3-5 days. Conditions were followed by a massive mortality. Importation of Japanese Nori strains appear to be of concern due to their performance in Japan. One species, Porphyra yezoensis, has been cultured beyond its natural range and has al-

most entirely displaced P. tenera (Kafuku and Ikenoue, 1983). However, the two Japanese species have been introduced into Washington and have never been found growing wild there. Water temperatures are colder than those in Japan where reproduction occurs (Washington, DNR, 1987).

Stringent stock certification and inspection programs currently required in Alaska can avoid accidental importation of exotic predators and disease organisms. It is desirable to avoid adverse effects on native species, such as those created by Japanese oyster drill (Ocenebra japonica), introduced into Washington, and now a major predator on native oysters (Weston, 1986).

Guideline 15a currently established in law, is included to avoid these types of impacts.

Disease Transmission

Disease transmission from cultured to wild animals is a major possible concern related to importation of broodstocks and exotic species investigated by Weston (op.cit.). Conservative importation policies of ADF&G minimize potential that diseased organisms would be introduced into Alaska. A stringent policy is needed because cultured animals are at higher densities than under natural conditions, facilitating disease spread. Very dense stocking results in stress that makes organisms more susceptible to diseases and pathogens which may only become virulent under such conditions. The basis for human health concerns is the food chain effects of bioconcentration occuring when pathogens accumulate in shellfish or fish which are subsequently harvested from cultures or from native populations, in close proximity to mariculture operations.

If bacteria of the genus Vibrio were to spread from cultured stocks to natural stocks, this organism would be of particular concern, because various species are pathogenic to shellfish, salmon, and humans and they are widespread in occurrence. Weston (1986) reviews available information about linkage between mariculture and increased incidence of Vibrio. He describes a possible route of increased human infection from sedimentation onto natural shellfish beds where bacteria would thrive under conditions of high organic input and where filter feeding molluscs would bioaccumulate pathogens. He describes several factors which he concludes contribute to a low incidence of infections in humans in general and could find little evidence mariculture contributes to proliferation of bacteria and strains pathogenic to humans. However, he did recommend floating facilities not be sited over harvestable shellfish beds to avoid sedimentation effects and noted this restriction would also minimize risk of pathogenic bacteria transmission to humans.

Adopting a siting guideline such as 1e adds another safeguard to already stringent policy toward importation of exotics and certification of stocks as disease free.

Disease and Parasite Control

In the event disease or parasite infestations should occur, efforts to prevent or control disease and parasites, and disposal of diseased animals could result in impacts on native stocks. Recommended methods of control vary based on cultured species and disease or parasite involved.

Three shellfish species likely to be cultured in Alaska have all experienced massive mortalities under some culture conditions in other areas of the world. Disease organisms have rarely been identified as causative factors; rather, death has generally been attributed to physiological changes resulting from stressful environmental conditions such as prolonged high water temperatures (Chew, 1987) or rough seas and wave rocking action (Motoda, 1977); improper handling of spat or seed (Ventilla, 1982; Wakui, 1983), and over stocking and resulting changes in water quality (i.e., self pollution) (Motoda, 1977; Koganezawa, 1979; Mottet, 1981; Ventilla, 1982; Wakui, 1983). Sinderman (1979) reviews many different and complex causes of oyster mortalities and identifies several oyster disease organisms.

Sinderman (1979) recommends methods for control of disease in oyster culture to include

environmental manipulation through cleaning dead shell beds, selective use of chemicals, and removal of intermediate or reservoir hosts; and of stock manipulation through moving oysters to less saline growing areas, planting at low densities, suspending at specific depths, moving oysters to low nutrient waters for part of the season, planting seed late, and harvesting early. He notes only one recommendation has been made for chemical control using organic mercury salts in early 1950's and this recommendation would not be made at the time the article was presented because of toxicity of these salts to other organisms. He also notes artificial propagation and development of disease resistant oyster stocks as a potential control technique.

Methods recommended for disease control do not appear to pose potential adverse environmental impacts. As described above, stringent control of exotic seedstock importation should minimize potential spread of exotic disease organisms.

In Scotland, mussels are parasitized by pea crabs (Pinnotheres spp.) and red worm (Myticola intestinalis) (Edwards, 1984). In Netherlands, parasites are a major mortality factor in culture of oyster species Ostrea edulis (Glude, 1979). Scallops also have naturally occurring parasites (Mottet, 1979; Ventilla, 1982). Suspended culture has been described as a technique which minimizes parasite problems (Herriott, 1984). Continued vigilance and stringent controls over importation of exotic seedstocks should minimize the potential for exotic parasite introduction into Southeast Alaska ecosystems.

Fungal, viral, and bacterial diseases have been discovered in Laminaria and Porphyra culture and epiphytic growth of various organisms is a problem (Neish, 1979). Techniques suggested by guidelines established by Washington Department of Natural Resources (1984) which spell out standard procedures for combatting these problems in Nori culture would not cause any adverse environmental impacts. Offering alternate food sources or enclosure in synthetic cages has been tried for protection.

Predator Control Techniques and Disturbance

As described above, mariculture involves maximizing single species productivity. Depending on natural populations present, eliminating competitors or predators may be desirable from the standpoint of the farmer. Mariculture can also involve considerable human activity resulting in disturbance and displacement of species which cannot tolerate noise or pollution. Finally, species such as bears may become problems because of human confrontation and mariculturists may desire to eliminate them as well. Site selection can avoid impacts to species likely to become competitors or predators or which are sensitive to human disturbance by avoiding known concentration areas. Wildlife species that are of concern to the aquatic farmer because they are "preditors" on a particular culture may be a concern to regulatory agencies because the newly found food supply is bringing them in human contact. The intruding human presence may disturb species in their habitat and the availability of the new food supply may turn them into predators which, if undisturbed, they would not be.

Hanging culture eliminates the majority of predation problems from bottom dwelling predators such as sea stars, carnivorous snails, and various crabs. Efforts are generally undertaken to remove starfish and other invertebrate predators that attach to cultures or enter spat collecting devices and trays by hand, but there is generally no need to kill them. Starfish occasionally enter suspended trays as larvae and grow large enough to consume small oysters (Church, pers. comm.). Starfish reportedly require only a single removal from mussel culture (Herriott, 1984).
Culture operations in areas other than Alaska have involved killing of invertebrate predators by use of quicklime (Magoon and Vining, 1981), but this practice can also kill many other animals as well. Some efforts may be made to trap crabs particularly in the vicinity of intertidal storage areas; crabs can be used for human food in accordance with sport fishery regulations. Predation problems can be minimized with other types of rearing structures by repeated checking and removal.

Marine mammals, some furbearer species, some invertebrate species, and a variety of bird species are attracted to mariculture facilities to prey on concentrated food source of their traditional food items. Predators on fish or shellfish cultures in Alaska are likely to include mink, land otters, harbor seals, sea lions, sea otters, bald eagles, herons, scoters and other diving ducks, and gulls. Sea lions, sea otters, scoters and diving ducks, and gulls are most likely to prey on shellfish cultures. Also, sea urchins, herbivorous fish, and some grazing snails may reduce productivity of seaweed culture through intensive grazing.

Steller sea lions prey on a wide variety of fishes and invertebrates, including bivalves such as clams and mussels. Based on review of food habit studies in the Gulf of Alaska, researchers speculate importance of schooling fish species might indicate a foraging strategy that minimizes effort and conserves energy (ADF&G, 1985). While shellfish are often not the most important component of their diet when schooling fish are available, presence of concentrated bivalve cultures may be extremely attractive to this opportunistic predator.

Sea otters are the predators most likely to conflict with shellfish mariculture because of diet preferences and their expanding range in Alaska. Reduced to near extinction in the early 1900's, rehabilitation efforts have resulted in repopulation of historical habitat, with scattered groups occurring throughout southeastern Alaska. Sea otters have a highly variable and opportunistic diet which has included purple hinged scallops, mussels, and a variety of clams. They tend to concentrate on a single prey item, feeding on it until it is drastically reduced. They also have an important "keystone" role influencing stability of nearshore communities. When introduced into an area with kelp beds, they can control macroinvertebrates feeding on kelp, such as sea urchins. This shifts kelp beds towards higher productivity which supports higher concentrations of small herbivores in turn supporting higher populations of fish that prey on small herbivores (ADF&G, 1985). Sea otters are potentially serious predators on shellfish cultures while their presence may benefit seaweed cultures.

Based on a study of food habits in Cholmondeley Sound, land otters are primarily fish eaters in Southeastern Alaska, although identification of shelled molluscs in scats is difficult if they are able to remove shells (Larsen, 1983). A study in the same area on mink food habits concludes mink forage in lower intertidal zones, feeding primarily on crabs, nearshore fish, and isopods. Quantification of the importance of bivalves in their diet was described as problematical (Johnson, 1985). Johnson (op. cit.) cites a study of mink trapped in the Petersburg -Wrangell area which documents a high percentage of clams in mink stomachs (Croxton, 1960 in Johnson, 1985). A shellfish culture could attract mink and otter and result in predation. Church observed mink feeding on crab and other organisms in surface oyster trays but not on oysters at a Blashke Islands culture site.

Several species of diving ducks feed heavily on bivalve molluscs. Scoters, goldeneyes, and harlequin ducks, in particular, feed heavily on mussels and may also find oysters palatable. One oyster farmer in the Blashke Islands reported no problems with bird predation on surface trays (John Church, pers. comm.) Gulls are opportunistic predators and may also prey on shellfish cultures; experimental bouchot culture of mussels was subject to severe gull predation in Ireland (Herriott, 1984).

Lethal methods of predator control offer the greatest impact mariculture could have on existing native wildlife. If facilities are not properly sited to avoid predation problems, killing predators cannot be assumed to be an acceptable means of control due to the current statutory and regulatory protection of most species. ADF&G considers mariculture facilities to be attractive nuisances to predators and does not favor destruction of predators under 5 AAC 92.410 (a)(2) which permits taking of animals in defense of life or property under some circumstances (Alaska Interagency Mariculture Workgroup, 1988). Other restrictions on harassment or killing of marine mammals, of migratory birds, or of

bald eagles exist in federal law, in Marine Mammals Protection Act, Migratory Bird Treaty Act, and Bald Eagle Protection Act, respectively.

Jefferds (1987) reports on chronic problems with scoter predation of mussel rafts in Washington. A variety of techniques were tried, of which net enclosure of rafts was most successful. He notes a problem with gulls able to get between the logs of mussel rafts from above and unable to get out either through the net or between logs. Several were drowned but predation on mussels did not appear to be significant. Line or string can also be strung as a web to minimize bird predation from the air (Herriott, 1984; M. King, pers. comm.). Canadian Department of Fisheries and Oceans (1986) recommends sheet metal collars on cables, boom sticks, and stiff legs which are attached to shore to prevent passage of furbearers onto floating structures. A French crab fence has been designed with plastic mesh walls supported by uprights with outsloping eaves dug into the beach to protect mussel rafts (Herriott, 1984). Finally, netting has been used successfully in beach culture of Manilla clam to exclude moon snails and other predators (Chew 1987) and in culture of butter clams to reduce predation by crabs, sea stars, and scoters (Gunn et al., 1983).

The Alaska Oystergrowers' Manual (Else, Paust, and Burns 1985) recommends use of mesh or plywood covers over oyster tray rafts to keep out birds and bears. Fencing has been recommended to keep crabs out of intertidal storage areas (Glude, 1979) and cages have been used to protect seaweed seedlings from predation by grazing snails (Saito, 1979).

Placing crops which may be taken by predators near the surface has been recommended for seaweed (Saito, 1979) and for mussels. Gunn et al. (1983) finds the provision of a sacrifice crop of mussels near the surface results in a productive crop 5-10 m below surface in an area with severe duck predation in British Columbia.

Whereas a variety of measures exist to minimize predation problems on hanging cultures, eliminating predators from bottom culture areas appears to be more difficult to accomplish in Alaska without resorting to lethal means used elsewhere. Starfish are frequent predators on shellfish. They are widespread and abundant in productive intertidal areas which are suitable for bottom culture. A variety of boring snails (whelks and drills) also occur; their potential as oyster predators is not known. In fact, many descriptions of bottom culture practices throughout the world emphasize cost considerations of methods which are generally less expensive than floating culture and describe lower productivity due to predation as an accepted consequence of selecting this method.

Human activity associated with all mariculture can displace species from preferred habitats or important concentration areas. These species include harbor seals, whale species, bald eagles, and many species of waterfowl, waterbirds, shorebirds, and seabirds. Sensitive habitat areas include harbor seal haul outs and pupping areas, heron rookeries, bald eagle nests, perch trees, waterfowl concentration areas, and seabird nesting colonies.

Improper disposal of garbage and waste from shore based facilities may attract brown or black bears. Church (pers. comm.) reported bears have destroyed beached oyster culture structures on some occasions, possibly because of its attractive smell as fouling organisms die and decay. Mariculturists create an attractive nuisance in these situations. Human development, in general, results in negative impacts on bear populations through displacement and bear mortalities following bear and human confrontations.

Guidelines 2a, 2b, 2c, 2d, 3a, 3b, 3c, 3d, 10a, 10b, 10c, 10d, 10e, 10f, 14a, 14c, and 14d were developed to avoid or minimize these types of conflicts.

Fouling Control Techniques

Organisms which grow naturally on a substrate of bivalve shells, on the surface of seaweed, or on mariculture structures are considered to be fouling the culture. As described in Capability sections for each species, fouling

organisms can reduce productivity through competition for nutrients or food items, parasitism, or restriction of water flow. Degree of fouling varies with site conditions; however sites with high phytoplankton productivity suitable for shellfish culture are ones most likely to have a high level of fouling organisms. Fouling has made culture of some species of seaweeds in Puget Sound (Mumford and Melvin, 1983) and of scallops in hanging culture in New Zealand (Blackett, 1987) economically unfeasible.

Major techniques for fouling control include: (1) air drying rearing structures and cultures to kill fouling organisms which cannot tolerate prolonged exposure (Korringa, 1979, Magoon and Vining, 1981; Kafuku and Ikenoue, 1983), 2) timing seed/spat collection or outplanting to avoid the settling of encrusting organisms (Ren-Zhi et al., 1984, Mumford and Melvin, 1983), 3) increasing stocking density by reducing spacing on ropes and strings (Mumford and Melvin, 1983), 4) suspending cultures lower in the water column e.g. below 5-6 m. for scallops in Japan, (Motoda, 1977; Mottet, 1979) and below 5-10 m. for mussels in British Columbia (Gunn et. al., 1983) or lowering them only during time of settlement, e.g. to below 30 m. in Japan for scallops to avoid barnacle setting (Ventilla, 1982); and 5) manual scrubbing or cleaning with high pressure hoses (Magoon and Vyning, 1981); and 6) biological control, using natural herbivores or predators (Else, Paust, and Burns 1985). Other recommended techniques for seaweed cultures include immersion of seaweed nets in citric acid and use of chafers, small discs on lines (Mumford and Melvin, 1983). Else (1985) recommends the following techniques for oyster culture in Alaska: 1) siting in areas with tidal action to discourage settling of fouling organisms, 2) deep suspension to discourage seaweed attachment and deter barnacle and mussel setting in the spring, 3) allowing rafts to dry out on a sunny, windy day, 4) cleaning gear by removing it from the water for at least one week then leaving it in half tide level for scavenging, 5) manual scrubbing, and 6) cleaning with pressure hoses. Else, Paust, and Burns (op. cit.) describe biological control of fouling organisms using their natural predators, an innovative approach which would restore some of the complexity to the culture habitat which is necessarily reduced by attempts to cultivate monocultures.

In some areas, antifouling chemicals have been used on structures but because these work by killing marine organisms, they may kill many nontarget organisms and may also bioaccumulate in cultured animals. One substance, tributyltin or TBT, has been prohibited for sale by statute in Alaska. Impacts could occur in beach or intertidal areas where gear or cultures are beached, particularly if wheeled or heavy equipment is used. Siting of mariculture facilities should take into account the proximity of beach areas of low biological productivity (e.g., gravel or sand beaches suitable for beaching or treating equipment to the site of floating culture structures. With exception of the use of antifouling substances, recommended methods of fouling control should not result in adverse environmental impacts.

Guideline 9d and 14b were developed to minimize impacts of fouling control.

Disposal of Wastes

Mariculture operations can generate a variety of potentially polluting wastes. These wastes include solid waste, sewage, waste oil, diseased or spoiled animals, etc. Improper disposal of garbage or organic wastes is of particular concern where it may become attractive to brown or black bears.

CONFLICTS WITH OTHER COASTAL USERS

Mariculture is a relatively new industry in Alaska and has potential to conflict with established uses. Many existing uses are dispersed over large areas while other activities likely to produce pollution are localized. These conditions provide opportunities to site mariculture facilities to avoid conflict with other users. Not all conflicts can be resolved, but most can.

Resource agencies in Alaska sometimes lack detailed information on all uses occurring in Alaska's vast coastal areas. Use patterns can be dynamic, varying dramatically in response to changes in natural conditions and government regulations. Resource agencies conduct planning and permit review processes to provide opportunities for existing and potential resource users to identify their needs.

Stringent water quality standards for growth of marketable seafood products will limit the suitability of sites to those physically located separate from areas with waste discharges. Determining acceptable separation distances will help guide any conflict resolution process and will determine areas where mariculture and other uses are incompatible.

This section will discuss major conflicts with other users of Alaska's coastal resources.

Land Management Issues

Resource agencies share responsibilities for development of new industries that depend on public resources for development. Primary land use manager for the state is the Department of Natural Resources (DNR). DNR is responsible for developing these resources while at the same time providing for resource conservation and protection.

DNR historically has been the state agency facing new industries needing access and use of state land, such as prospective barley farms, coal mines, petrochemical plants, shore based seafood processing facilities, geothermal energy developments, and cattle ranching. Developers need assurance of long term property rights to secure financing and so they don't lose control of sites in which they have made significant capital investments. DNR's responsibility is to ensure that commitment of state lands will be lawful, in the public's best interest and will produce viable new industries, useful products, stable jobs, and hopefully a fair market value.

Other resource agencies such as ADF&G and DEC review development proposals under their statutory authorities and also provide guidance to DNR for development and protection of resources in their areas of responsibility. These agencies and others share in the Alaska Coastal Management Program (ACMP) which provides for a coordinated review of all coastal development in Alaska.

Aquatic farming may become a significant long term use of state tide and submerged lands. Alaska must achieve balance in its regulatory programs which will allow this industry to thrive, while at the same time protecting existing uses of land. Problems that may occur if balance is not acheived include displacement of public uses such as recreation and fish and wildlife harvest, conflicts with other commercial uses of tide and submerged lands, land speculation, impacts on adjacent land holders, and stifling of an emerging industry.

Mariculture Development Land Use Needs

Successful mariculture developments share a number of basic requirements. Foremost among these is a need to secure appropriate sites. Desirable features of a mariculture site are also often desirable for other uses, such as anchorages. Even in rural Alaska, it is a rare mariculture site that does not also attract other users.

Resolution of use conflict usually involves two approaches:

1. Separating uses geographically. Competing uses can often be separated to avoid conflicts.

2. Mitigating measures, such as site design, timing restrictions on use, or access corridor stipulations may allow more than one use of a site and resolve conflict.

Unfortunately, not all conflicts can be resolved to allow multiple use of the same site. It is then the land managers responsibility to determine best use of state lands. Such conflicts are more likely to occur in areas not covered by an appropriate land use plan. Experience has been, however, that many conflicts can be resolved using the State's coastal management program project consistency review system. This system has been developed and refined by state agencies over many years of permit review and conflict resolution.

Displacement of Public Use

Structures on tidelands can physically displace or obstruct other uses requiring surface access. Mariculturists sometimes apply for use of areas larger than the physical dimensions of proposed structures (see Table 3-3) to minimize impacts to their operations from other human activities. Physical displacement can exist for farm site as well as for upland facilities. This may affect an even larger area if other human activities require a degree of solitude.

Culture technique is one variable determining if displacement will occur, and the magnitude of physical displacement. Bottom culture and submerged structures have least impact on natural resource harvest, boating and on aesthetic enjoyment, but may displace fish and wildlife harvests of bottom dwelling species such as crab and clams.

Both longlines and rafts can interfere with recreational and commercial harvest activities. While longlines require only surface floats, in contrast to log boom structures commonly used as rafts, very extensive longline grids are used in other countries such as Japan (see Table 3-4).

Floating culture of shellfish and seaweed are commonly kept separate through negotiation in other countries. Japanese, fishing cooperatives allocate uses, prohibiting fishing boats and nets in areas of seaweed culture, (Olson, 1987) and prohibiting suspended culture in nearshore areas where fishing rights are maintained over bottom culture areas (Ito et. al., 1975).

Aesthetic conflicts are less tangible than physical displacement. Longlines may be less objectionable than rafts in terms of their visibility, however some people object to floating structures in front of recreational homes or cabins, and to associated activities and noise resulting from mariculture operations. Aesthetic objections from recreational home owners have been an issue in New Zealand (Dias 1984), in Washington (Freeman, 1985; E. Hurlburt, pers. comm., 1988), and in British Columbia (Butler, 1986).

Recreation

Expectations and desires for seclusion when recreating in rural Alaska is highly valued by residents and visitors. A mariculture facility, particularly with caretaker facilities located in a smaller cove, will essentially eliminate that sense of seclusion for recreation users. Those recreation users tend to find other secluded and aesthetically pleasing areas. Coastal resources may receive competing uses in many areas. Degree and intensity of recreation pursuits are difficult to define and may be dynamic in nature. Rural coastal areas receive dispersed recreation activities by small groups or individuals at widespread and diverse sites.

Mariculture development has the potential to block or inhibit public access to coastal recreation areas. The ACMP recreation standard requires state agencies to give high priority to

maintaining public access to coastal waters. Mariculture operations that would form a barrier between coastal waters and shorelines, or that would prohibit access to important costal areas, could be found inconsistent with ACMP requirements.

Anchorages

Potential conflicts exist between anchorages and mariculture development. Mariculture sites need room for floats, rafts and other waterborne structures. They also need pristine waters free from high coliform counts and other forms of pollutants. Some organisms and growing facilities are adversely affected by waves from boat wakes.

Boats need room to maneuver and anchor. Some boats inadvertently discharge waste products into water. Some boat operators may ignore sound waste management procedures and choose to discharge contaminants at will. Not all boat harbors in Southeast Alaska have adequate holding tank pumping stations available making it difficult for even conscientious boaters to comply.

Raw sewage means contamination of marine organisms by coliforms. Waste products such as chlorine used by some boats to flush sewage tanks and bilges are highly toxic to mariculture organisms. Heavy metals associated with fuel and oil wastes are readily absorbed and held by many species of sea vegetables.

Current information indicates large, heavily used anchorages, or small, strategically located anchorages and mariculture facilities are incompatible. Sewage, chlorine from sewage systems, diesel, oils or other waste products discharged from boats near a mariculture facility may result in unacceptably high coliform counts or other forms of pollution. Infrequent boat activity, that does not discharge harmful products into the water is not a major problem.

This situation could be improved by the compliance by all boats holding sewage and waste products for acceptable disposal. Development of dumping facilities in more commercial harbors may also help to alleviate sewage problems.

Proposals for mariculture sites proposed in known anchorages should include alternate anchorages nearby. High use anchorages with no nearby alternative anchorages will have difficulty being permitted or leased for mariculture sites. Smaller, secondary anchorages with alternate anchorages nearby will probably be more successful in obtaining necessary authorizations.

Mitigating measures for this conflict usually means locating the two facilities far enough apart so there is no conflict. Another potential mitigating measure might be adoption of a "relay" system. Under this system shellfish are taken from contaminated or polluted areas to noncontaminated waters. Shellfish are held for a minimum of two weeks to cleanse themselves. Testing indicates when the acceptable product is released for sale. Actual time for this cleansing process may be considerably more than two weeks.

Relaying has not been tried in Alaska. It may require substantial handling and facilities that would add to the cost of products. Further testing would be needed if this system is considered.

Fish and Wildlife Harvest

Recently passed legislation requires that regulations must provide for the consideration of upland management policies and whether the proposed use of a site is compatible with the traditional and existing uses of the area in which the site is located. Both longline and raft culture techniques involve structures that can interfere with commercial and noncommercial harvest of fish and wildlife. Longlines require only floats on the surface, in contrast to log boom structures commonly used as rafts. Extensive longline grids are in use in other countries. (See table 3-4)

Conflicts between mariculture structures and other uses depend partly on if the farmer needs to restrict boat traffic. For example, farmers may wish to limit boat traffic to minimize potential for vandalism and pollution from fuel and sewage. Conversely, personal use crab fisheries may be very productive around rafts used for culturing sea organisms.

Because communities that use the study area are currently considered subsistence communities, subsistence harvests are important activities in most areas where aquatic farming may occur. Conflicts between mariculturists and subsistence users could occur as more facilities are developed. Development of direct competition for subsistence resources may increase as new residents enter rural areas. Loss of subsistence opportunities could occur if mariculture facilities are placed in important subsistence resource areas.

Results of a subsistence study currently being conducted by ADF&G, Division of Subsistence will be helpful in identifying potential conflicts.

Conflicts with Other Commercial Uses of Tidelands and Submerged Lands

The best sites for aquatic farm facilities may often be the best sites for other uses such as mineral or timber transfer and support facilities, log storage, commercial fishing grounds, anchorages, or commercial recreation development. Although mariculture is a new industry in Alaska, some conflicts have surfaced in Kodiak, Prince William Sound, and Southeast. Besides need for space, water quality standards for mariculture may preclude use of favored sites for other commercial or industrial facilities. Forcing more stringent mitigation measures or alternative siting for timber, mineral transfer, or tailings disposal could reduce or eliminate economic viability of resource extraction industries in a given area.

Conversely, mineral or timber transfer sites, log storage sites, and floating camps associated with resource development activities may limit space available or degrade water quality for mariculture facilities, making mariculture development more difficult and less likely.

Commercial Fishing

In the study area, commercial fishing seldom occurs in secluded coves and bays that are more commonly suitable for mariculture. Nevertheless, these protected coves may be important to the commercial fishing fleet because they provide safe anchorages close to fishing grounds or tenders.

Potential conflicts may develop due to fishing hook-off points. These are locations near shore where commercial fishing nets are set for harvest of fish. Hook-off points can occur virtually anywhere along shorelines free of rocks or other obstacles that would tangle nets. Some hook-off points are valuable sites for fishing boats as fish migration patterns bring them to the same area year after year. Culture techniques utilized by mariculture operations that restrict use of open shorelines have the potential to conflict with hook-off points.

Conflicts may be limited to those times of year fish harvest occurs. Separation of uses may be the only practical solution to this type of conflict.

Commercial Recreation

Commercial recreation in the form of hunting, fishing, and guiding, or the establishment of recreation lodges have potential for conflict with mariculture development. Aside from potential physical displacement, such recreation development could provide sources of point pollution.

Type and degree of conflict can only be determined on a case by case basis.

Logging

Conflicts with timber harvest operations may occur because floating facilities can interfere with log transfer and floating storage operations. In the study area, timber harvest on Forest Service lands is continuing, and operations require log transfer at tidewater, storage of log rafts in protected bays and inlets, and towing rafts to mills. Conflicts may arise because of: 1) the overlap of many siting and operational requirements for log transfer and storage and for mariculture, particularly a requirement for protected waters, and 2) the potential for degradation of water quality in the vicinity of log transfer facilities.

Log transfer and storage area siting involves a detailed review of potential environmental impacts and conflicts with other uses. Suitable sites which meet environmental and industry criteria are generally limited in number. Unless mariculture, log transfer and storage can coexist, there may be direct competition for sites.

Bark and other organic debris resulting from log transfer and storage can have adverse impacts similar in nature to those associated with floating mariculture facilities (Pacific Northwest Pollution Control Council, 1971; Pease, 1974; Schultz and Berg, 1976; Duval and Slaney Co., 1980). Anaerobic sediments can form and hydrogen sulphide may be released. Freese and O'Clair (1984) documented a relationship between low dissolved oxygen concentrations, high hydrogen sulphide and ammonia concentrations, and mortality in mussels and littleneck clams exposed to decomposing wood wastes under laboratory conditions. Decomposition of log wastes can also release leachates which are toxic to some species of shellfish (Buchanan et al., 1976).

Close proximity of log transfer facilies and floating mariculture facilities in small or poorly flushed waterbodies could result in contamination, disease, or mortality of cultured animals. Bottom culture should be precluded in areas where large quantities of bark could potentially be deposited. Intertidal storage and upland support facilities should be located to minimize potential problems.

Other types of water quality conflicts may also occur. Use of pesticides at dry land log storage sites has been proposed in Alaska (e.g., the use of lindane mixed in diesel oil to control ambrosia beetle at Thorne Bay in 1983). These substances can bio-accumulate in shellfish. Requirements for boat and seaplane traffic for timber harvest and transfer operations also increase the potential for hydrocarbon pollution. Sewage discharge from logging facilities would be of concern as a possible point source of pollution. Logs are sometimes lost and floating debris could damage mariculture structures.

No known mitigating measures exist that could increase compatibility. Distances between TTF's and mariculture sites are determined largely on a case by case basis due to currents and other physical characteristics of the area in question.

Mining

Potential conflicts in the form of direct competition for suitable sites for mineral transfer and mariculture are similar in nature as those between mariculture and logging activities. Remote hardrock mine sites require upland facilities for processing ore, transfer facility operations, and for loading barges transporting ore to markets. Options for siting mariculture facilities in close proximity to mine sites are limited. Water quality impacts can result from mining operations. Disposal of tailings in marine waters that contain high concentrations of heavy metals or result in high levels of turbidity and suspended sediments are inherent conflicts. The potential for water pollution from sewage discharge, boat fuel hydrocarbons, and waste oil is similar to that for logging support facilities and operations.

Urban Development

Industrial and commercial development of shorelines may conflict with requirements of mariculture developments through physical competition for space or through a variety of pollution sources. Degree and type of impact is site specific.

The U.S. Forest Service manages most lands in the study area. No urban development is planned at this time.

Residential Development

Residential development along shorelines or floathomes can compete for physical space with mariculture facilities. Residential development can also result in point source discharge of sewage. Shoreline residents can object to mariculture on aesthetic grounds. One subdivision, Olive Cove, exists in the study area with both private and state ownership. Conflicts between mariculture facilities and residential development may be minimal. However, public and agency review should address these potential concerns if mariculture development is proposed in this area.

Historic or Archeological Sites

Upland development associated with mariculture is not compatible with historic or archeological sites. By law, these sites must not be affected or, as a last resort, extensive mitigation is required to identify and record values before impact occurs.

Because of limited surveys of variable intensity, all historical and archeological sites have not been located within the study area. Location of known sites will not be provided in an attempt to prevent vandalism.

If a U.S. Forest Service Special Use Permit is required, applicants must initiate a site survey by a qualified archeologist. The Special Use Permit will normally be denied when historic or archeological values are found on or adjacent to the requested site. State permits may similarly require extensive mitigation or be subject to denial on these grounds.

Land Speculation

Prior to 1986, British Columbia experienced a dramatic rush for permits which allowed the holder to enter and occupy a site to conduct research for up to one year. It appears that these permits were being issued for large areas of land with little regard for potential impacts to the public. A gold rush image was created resulting in a great deal of public concern, and subsequently a moratorium was imposed. Alaska does not have an investigative permit similar to this permit but we could experience land speculation in other forms, most notably by applying for permits and leases to tie up a site.

Land speculation in this case is described as obtaining land use rights with the intent of not using the land for proposed uses but selling or trading those rights for a profit. This problem is not unique to mariculture and can occur in any use of state land. Speculation can be greatly reduced by close monitoring of development schedules and writing conditions in land use documents that would allow agencies to revoke permits or leases if the development is not proceeding as proposed.

Impacts on Adjacent Land Owners

Mariculture can impact adjacent land owners in a variety of ways: loss of tidelands access or boat moorage, loss of view, noise, loss of privacy, loss of habitat, and changes in water quality. This has been a significant issue in Washington and British Columbia, and may become a concern in Alaska.

Adjacent land owners have a number of ways to participate in mariculture facility siting. They can participate in development of state land use plans, coastal zone management programs, and local comprehensive plans. Adjacent owners are notified by mail of pend-

ing applications and are given an opportunity to comment on projects. A 30 day public notice pursuant to AS 38.05.945 is required for leases. Local governments, regional or village native corporations, local coastal districts, and communities are also notified. Local government or regional native corporations may hold public hearings if necessary. Department of Natural Resources reviews all of these comments and weighs the use and enjoyment of the adjacent owner against what is considered to be state's best interest.

Land use conflicts on uplands are adjudicated in the study area by Forest Service officials utilizing the Tongass Land Management Plan.

Upland Access

Access is a major consideration under current permit and lease review processes. A part of the state's "best interest" determination is an evaluation of impacts on access, especially to upland owners. Access is important for recreation and fish and wildlife harvest on public lands. Access by water craft, aircraft and in some circumstances by land vehicle can occur.

In most circumstances, access problems can be mitigated on a mariculture site by specification of easements or access corridors on permits or leases. In some circumstances there is not sufficient room to separate two uses. In these cases access may be allowed over other forms of development if a reasonable alternative cannot be found.

U.S. Forest Service as Upland Managers

As primary managers of uplands in the study area, the U.S. Forest Service has the responsibility of management of upland permits for mariculture development. Land use designation (LUD) I, II, III, and IV of Tongass Land Management Plan provides guidance for development in Tongass National Forest.

Following is a brief description of the four major land use designations for Forest Service lands:

LUD I (and LUD I Release Areas) - This designation is primarily a wilderness designation. It provides for minimal development compatible with maintenance of natural character of land.

LUD II - This designation is managed in a roadless state to retain its wildland character but would permit wildlife and fish habitat improvement and primitive recreational development. (The study area contains no LUD II lands)

LUD III - This land is managed for a variety of uses. Emphasis is on managing for uses and activities in a compatible and complementary manner to provide the greatest combination of benefits. These areas have either high use or high amenity values in conjunction with high commodity values.

LUD IV - This area will be managed to provide opportunities for intensive resource use and development where emphasis is primarily on commodity or market resources.

The southern half of Etolin Island is currently designated as LUD I Release. These lands are being managed to provide opportunities for solitude and primitive types of recreation in unaltered environment.

Components of mariculture projects occurring above mean high tide line must be compatible with the goals of the LUD classifications. Development in LUD IV areas is more acceptable than within the LUD I Release area. Development in all LUD areas will be restricted to structures specifically designed to blend into surrounding landscape. Size, location, and color of structures and the amount of trees to be removed will be specified by the Forest Service for development in all LUD's. Although goals for TLMP do not apply to the waters below mean high tide the U.S. Forest Service expects permitted activities on water adjacent to the Forest will be compatible with management direction for surrounding uplands.

There is currently one Special Use Permit for an upland facility to support mariculture development in the LUD I Release area. No more permits will be issued unless the designation changes to LUD II, III, or IV.

The U.S. Forest Service is presently revising its land management plan for the Tongass National Forest including the Etolin Island area. Specific direction on how the resources on Etolin Island will be managed will appear in the plan. Until the revision is completed current Tongass Land Management Plan direction and guidelines will apply to mariculture developments.

Cumulative Effects of Expanding Tidelands Use

For most of coastal Alaska, mariculture facilities are permitted on an individual basis. Impact from one or two farms may be minimal, but cumulative effects of numerous farms on existing uses may be dramatic. DNR management and area plans provide a process for resolving use conflicts on a regional basis, and best interest findings required under AS 38.05.035(e) provide mechanisms for resolving conflicts on individual permits/leases. The ACMP consistency review process also provides a mechanism for resolving conflicts regarding use of state tide and submerged lands.

Although a regional perspective is preferred, cost of management and area plans limits their use as a routine method of sorting out problems and resolving conflicts. Lack of a regional perspective could lead to significant conflicts over time and is a major problem with the existing process.

During development of statewide guidelines, Alaska could evaluate British Columbia experience during its initiation to finfish aquaculture. Immediate needs for coastal planning occurred when it became apparant that a loss of access, a loss of anchorages, impacts on upland owners, impacts on recreation, and tourism. British Columbia placed a moratorium on leases and licenses for finfish farming and began an inquiry into finfish aquaculture and its impacts. Inquiries were completed in 1986. How well their conclusions or recommendations apply to Alaska conditions is uncertain.

Summary

While numbers of potential problems are large, it appears most land use problems associated with mariculture can be resolved. Appropriate land use plans and permit review processes, such as ACMP consistency determinations, are useful to resource agencies to accomplish resolution of conflict. Developing comprehensive area plans is desirable but time consuming (2-3 years) and expensive. Refined policies and regulations are being developed from newer and more accurate information by all resource and review agencies. This will greatly assist land management agencies in resolving conflicts among coastal users.

DEVELOPMENT

Costs of Production

ReLonde (1987) has created an economic model of oyster operations. which appears in the Alaska Oyster Grower Manual. He examined costs associated with raising oysters in shallow trays supported by rafts and in lantern nets. From this model he concluded that for oyster farms to be profitable in Alaska they must plant at least 250,000 spat a year. ReLonde estimated that a positive cash flow will be generated in the third year, and the facility will be paid off in ten years.

Most farmers feel that his estimates are high, because they, by necessity, economize wherever possible. For example many farmers use logs found along the beach for raft construction. In areas where there are no ongoing logging operations, these beach logs are readily available, but at sites such as those in the Blashke Islands, there is an abundant supply.

Start-up Costs

Rafts (4' by 12' to 4' by 20') cost $45-60 each to construct: materials cost $25-40 and labor costs about $20. Don Nicholson currently has over 60 such rafts, and is continually constructing more. To hold 200,000 oysters (50% juveniles and 50% adults) requires at least 65 rafts. Additional rafts are needed to hold the trays for spat and about 15% of the rafts should be beached to kill boring worms which, if left unattended, will destroy a raft in 2 years. Thus, approximately 100 rafts are necessary.

Rafts can also be constructed out of 6" PVC pipe, and these do not suffer from the damage caused by boring organisms. However, the initial cost of the rafts is $140-160 each. Fifteen percent less PVC rafts are needed, because there is no need to beach them for extended periods to kill the boring organisms. Total raft costs would be between $5,500 and $12,750.

Other major out of pocket expenses include a survey of the land ($1,500-4,000) and transportation for water certification samples which cost approximately $1500. Construction of the caretakers cabin, storage facilities, purchase and operating expenses for boats and skiffs are also necessary.

Labor

The Westcott Oyster Company is one of the most successful oyster operations along the Pacific coast. It produces about 1,000,000 oysters a year. It employs 12 persons on a full time basis with an average wage of $5 an hour for an annual payroll of $124,800. Westcott makes little money on its sales of adult oysters, and generates its profit from its sales of spat and equipment to other farmers (personal communication from Don Nicholson to Guy Oliver 1-23-88).

Farming generates local income. Initially this contribution is small. Individuals who are succeeding at oyster farming are those who are willing to work hard, be their own boss, and enjoy living and working in a remote setting. It is not only a business decision to get into shellfish mariculture, but also a choice of lifestyle. Oyster farming is a labor-intensive operation. Don Nicholson estimates that he must handle every oyster 6-7 times from the time that he receives them as spat until he packs them for shipping. To produce oysters for the gourmet market, which is the only market in which Alaskan oysters can effectively compete, each handling involves scrubbing and sorting not by the bucket load or shovelful, but individually.

The following is an example of a timetable for oyster farm development:

Year 1
obtain initial permits
construct rafts
place test spat at several sites
learn the basics of oyster farming

Year 2
construct more rafts
tend juveniles
place more spat in water
compare growth rates from test sites

Year 3
obtain final permits
build more rafts
tend juveniles
place spat in water
first harvest of adults

Year 4
build more rafts
tend juveniles
place spat in water
harvest adults

Year 5
replace rafts constructed first year
tend juveniles
place spat in water
harvest adults

Paralytic Shellfish Poisoning (PSP) Costs and Concerns

Growers and regulators have expressed the common concern that farms not be located too close together. They believe that water which flows over on operator's rafts should not directly flow over another's until it has had adequate opportunity to be well mixed with water from other sources. Without this mixing, depletion of food and nutrients, possible transmission of disease, or increased likelihood of fostering conditions for PSP-producing blooms could occur.

Monitoring for PSP should be initiated immediately upon start-up and continue on a regular and frequent basis throughout at least the first 5 years of the operation.

Don Nicholson of Canoe Lagoon Oyster Farm estimates that PSP testing costs him about $114 per lot, and this assumes no increased mortality due to oysters being refrigerated out of water. Detailed costs are: 80 oysters valued at $0.40 apiece ($32), round trip from Blashke Island to Coffman Cove ($12), express mail shipment of the parcel to Palmer ($20), and 6 hours of his time ($60). DEC does not charge farmers to perform the test. David Wieler of D&B Labs in Ketchikan is seeking to become the first private lab authorized to conduct PSP testing and he anticipates charging $60 per sample. Whether farmers will decide that the additional costs of the testing offset the in-transit time to the Palmer lab remains to be determined. For farmers seeking to provide customers with regular shipments of fresh oysters (weekly to biweekly), PSP testing may be a significant expense.

About 2-4 days lapse from the time the oysters are removed from the water until the time that test results are received from DEC and the shipment is authorized. Transit time for the samples from the remotely situated farms in the Etolin Island area to Palmer is responsible for most of the delay since the DEC lab expedites the testing as soon as samples are received. The grower is generally notified of certification by telephone in less than one working day after samples arrive at the Palmer lab. The oysters can not be released for distribution until DEC certification is received.

While the Palmer DEC facility expedites samples for PSP testing, the Palmer location is viewed as a significant handicap by some growers in Southeast Alaska who believe that by decreasing shipping distance, in-transit time for samples and total waiting time for PSP clearance would be reduced.

In addition to possible mortality during the wait for PSP certification, there is the problem

of product degradation. This especially impacts products destined for the gourmet market. DEC requires refrigeration or the equivalent for all oysters awaiting results from PSP tests. Oysters have a limited shelf life. When stored at 60-70o F maximum shelf life is 5-6 days, when refrigerated at 36-44o F it is 7-10 days, and when maintained at 32o F it may increase to 21 days. However, products near the end of their maximum shelf life, while safe to eat, frequently have deteriorated quality to where they are no longer acceptable in the gourmet market.

Transportation

While historically a large portion of oysters produced in Southeast Alaska were consumed locally, most oysters produced today are destined for distant markets. Alaskan oyster growers are aiming their product and marketing strategies at the high end half shell gourmet market. Only here, they believe, can the market support sufficiently high prices to cover the Alaskan costs of production and transportation.

Products aimed at capturing a portion of the gourmet market must be shipped as quickly as possible from the farms to distant markets. There are no alternatives to air shipping if the oysters are to be in prime condition when they reach Anchorage, Seattle, and New York. Shipping adds $1.00 per dozen to oysters delivered to Anchorage and Seattle and up to $1.85 for East Coast markets.

Marketing

Marketing requires different skills than farming. However, the current small mariculture production offers little incentive for persons other than farmers to be involved in the marketing of their products. The result is that farmers must increase volume to lower their costs of production and to offer the incentive for distributors and marketers to handle their products. To increase production farmers must spend more time at their farms, but now they must market and distribute their own product, which is difficult to do adequately from remotely situated farms. As shown in previous sections it is often remotely situated farms which have the least land and water use conflicts.

Farmers are currently selling oysters for $4.70/dozen FOB Ketchikan. Subtracting costs associated with transportation to Ketchikan and PSP testing yields a price of $0.31 per oyster. This price is adequate for the farmer, but leaves little for marketing costs. Don Nicholson (pers. com.) estimates that with volume sales a farm price of $0.20-$0.25 may be realistic.

Mariculture markets are no longer supplied by single producers, rather suppliers from around the world may be competing in a single market. Alaskan growers are in competition with growers
from other states and British Columbia. Alaskan oysters are high quality and have an exotic appeal because of the perceived pristine quality of Alaskan waters. British Columbian oysters are also perceived as being grown in pristine waters and are less expensive. British Columbian farmers currently receive $3.00 (Canadian) per dozen oysters or about $0.20 (U.S.) per oyster. To remain competitive the Alaska oyster industry must increase its volume, reduce its costs of production and establish a different marketing and distribution network which will allow the growers to concentrate efforts on the farms.

GUIDELINES AND MITIGATING MEASURES

Relative Measures of Suitability

In developing a mariculture facility several factors need to be considered: 1) if the site is capable of commercial production, 2) if the site is able to meet requirements of facility design, and 3) if the development is an acceptable use of public land and water.

Interactions between factors are complex, and may fluctuate from season to season or from year to year. The economic environment may support development, or can contribute to failures. Other uses sometimes compete for limited resources.

The following discussions are presented to assist agencies or individuals in determining the suitability of a site for select species of shellfish or kelp. It is unlikely any single site will be the "million dollar" site in all respects. Therefore, these indicators will be helpful in estimating the relative
suitability of mariculture sites.

Guidelines for Siting Shellfish and Sea Vegetable Mariculture Facilities and Mitigating Impacts

"Mitigation" is the process of avoiding or minimizing adverse impacts. Proper siting of shellfish and seaweed mariculture facilities should result in avoiding the majority of adverse impacts that might otherwise occur.

Conflict over mariculture siting has resulted in development of siting criteria and zoning in both Washington and British Columbia. In both areas, conflict has primarily been over finfish net pen siting. However, guidelines developed are in use for "all aquaculture proposals involving floating structures and improvements" in British Columbia (B.C. Ministry of Forestry and Lands 1987).

Proposed siting guidelines are based on a review of interim guidelines for management of salmon net pen culture in Puget Sound (Science Applications International Corporation 1986), on draft guidelines for development and operation of aquaculture and fish processing facilities (Department of Fisheries and Oceans Canada, Pacific Region 1986 a,b), and on siting guidelines developed by ADF&G for other forms of coastal development and by DNR for area plans.

Guidelines proposed here are based on several assumptions: 1) mariculture in the near future will be similar to that currently practiced (i.e., floating structures will be used, but bottom culture techniques may be proposed), 2) regardless of culture technique used, exclusive use of areas will be desired by farmers, 3) sites require expansion potential, 4) farms require potential for access to and use of adjacent uplands for support facilities and use of intertidal zone and beach above high tide for beaching gear, and storing or hardening shellfish. Some criteria are in conflict (e.g., increasing stocking density to reduce areal extent to minimize user conflicts vs. decreasing stocking density and increasing areal extent to minimize sedimentation impacts). Applicability of each guideline will depend on specific sites and proposal under review but they are included in this report as guidelines to both prospective sea farmer and to project reviewers.

Fish and wildlife concentration areas and human use areas described have been mapped as part of this project for the Etolin Island area.

Guidelines are organized into three phases: 1) siting, 2) project design, and 3) operations. If sites can be selected which avoid areas described under Siting Guidelines, then measures described in subsequent sections to mitigate impacts through design or operation may be unnecessary.

Siting Guidelines

1. To minimize adverse impacts on productive benthic habitats:

1a - Conduct a site survey to determine flushing regime, benthic community composition, and baseline water quality (i.e., dissolved oxygen levels, presence of toxicants or contaminants).

1b - Site floating facilities and intertidal structures where currents are strong enough to disperse suspended organics and organic deposits. Avoid siting in small embayments with sills, natural restrictions to tidal exchange, or existing water quality problems.

1c - Site floating facilities or structures embedded in the substrate in areas with least productive benthic habitat. Avoid shallow areas (less than 40 feet deep at Mean Lower Low Water).

1d - Because bottom culture site requirements are likely to conflict with maintenance of existing productive benthic communities, detailed site analysis including a dive survey should occur prior to siting. Bottom culture requirements should be defined. Information on the existing benthic community, proposed methods of reducing or eliminating predation, stocking rates, and potential effects on competing species should be provided. Feasibility of culture in alternative sites which have lower benthic productivity should be evaluated.

1e - Avoid siting within 300 feet of herring spawning areas, hard shell clam concentration areas, and eelgrass and kelp beds. Avoid siting sea vegetables farms within 300 feet of herring spawning areas and eelgrass beds.

1f - Select least productive intertidal or upland areas for activities involving dredging, fill, significant compaction of vegetation and sediments (e.g., filling or mechanized access), or flow alterations. Avoid use of equipment in productive habitat, particularly tideflats and salt marshes.

1g - Do not allow floating structures to ground at any tidal stage, except for planned beaching of gear for cleaning or fouling control. Beach gear in the intertidal area or beach area of lowest biological productivity. Sand or gravel beaches are the preferred sites; avoid tideflats adjacent to streams and salt marshes.

2. To avoid disturbance of sensitive fish or wildlife species or species during sensitive life history stages:

2a - Avoid siting within 330 feet or within a distance determined by the U.S. Fish and Wildlife Service of bald eagle nests.

2b - Avoid siting within a 300 foot radius of mouths of anadromous fish streams at Mean Lower Low Water.

2c - Avoid siting within one mile of: 1) harbor seal haul out concentration areas or pupping areas, 2) sea otter concentration areas, pupping areas, or feeding areas, and 3) seabird colonies.

2d - Avoid siting within waterfowl and shorebird seasonal concentration areas.

These guideline distances can be modified on a site specific basis if other measures will mitigate the disturbance or if disturbance is determined to be insignificant.

3. To minimize the effect of creating an attractive nuisance to potential predators or scavengers:

3a - Determine bird or mammal species which are expected to be a predator on the cultured species. Guideline distances for separation from concentration areas to avoid disturbance (#2 above) should be used as criteria if the species is a potential

predator. Distance of separation between rearing facilities and predator concentrations can be modified on a site specific basis if other measures will be implemented to minimize predation.

3b - Avoid siting mariculture facilities, including upland support facilities, adjacent to brown and black bear concentration areas.

3c - Avoid siting shellfish farms within areas where diving ducks, particularly scoters and goldeneyes, concentrate seasonally. Rafts or longlines may be sited within 1 mile of concentration areas if they can be sited in waters deeper than the birds traditionally feed on shellfish beds.

3d - Avoid siting shellfish farms within one mile of sea otter concentration areas.

4. To minimize conflicts with and displacement of traditional commercial and noncommercial users of fish and wildlife:

4a - Avoid siting in or adjacent to:

- Intensive commercial crab fishing areas
- Intensive commercial shrimp fishing areas (pot, trawl)
- Intensive commercial clam harvest areas (e.g., geoducks)
- Intensive commercial abalone harvest areas
- Intensive hunting areas (waterfowl)
- Intensive noncommercial fish and wildlife harvest areas
- Intensive anchorages within day use areas of major communities for sportfishing and other anchorages of local or regional importance
- Intensive float plane access areas
- Areas of restricted navigation

["Intensive Use" will have to be determined on a case-by-case basis. Generally, ADF&G conducts an assessment of the importance of a particular harvest area during permit reviews. The public will also have an opportunity to comment. Due to the variety of uses and lack of data, it is difficult to set specific thresholds. Intensive uses identified here have been identified as ones likely to constitute a conflict in specific situations.]

5. To minimize interference with fisheries enhancement activities:

5a - Avoid siting facilities adjacent to hatcheries or within terminal harvest areas.

6. To avoid adverse impacts relating to water quality:

6a - Applicants should gather site specific information on possible contamination sources, and avoid siting facilities in areas with waste discharges. (e.g., sewage, mine tailings, boat use, etc.)

6b - Applicants should gather site specific information on water characteristics to ensure that adequate water quality can be maintained once culture operations commence. (e.g. salinity, tidal flushing, currents, depths, temperature, etc.)

6c - Applicants should gather site specific information on levels of PSP which may occur naturally in the area, both in native shellfish and bottom sediments.

7. DNR Land use permit/lease guidelines:

7a - Mariculture and competing uses. Mariculture may be allowed on state tidelands where there is no significant conflict and if the proposal is not in conflict with other guidelines. Siting of mariculture facilities may be more difficult on tidelands used for, or designated in area plans for use by, log transfer or storage, mineral transfer or access, and commercial activities. Approvals to locate mariculture facilities adjacent to existing or planned land sales, in crucial fish and wildlife habitat areas, developed recreation areas, and areas used intensively for harvest of fish and wildlife or

for anchorage will also be more difficult to obtain.

Consistent with other guidelines, these areas will be available for mariculture: 1) if land mangers determine it is possible to site, design, and operate the two or more uses compatibly in the area, or 2) there is no feasible and prudent alternative for mariculture while one does exist for competing use. In no case will mariculture be allowed to foreclose access to mineral, timber, or recreation resources unless feasible or prudent alternative access exists. However, in some cases it may be in public interest to concentrate uses in one bay rather than allowing proliferation of uses in many bays.

7b - Upland owner support for mariculture. Upland owners are encouraged to identify areas where mariculture (including upland facilities) should and should not be developed and to communicate their conclusions to DNR and to the mariculture industry. Tideland development for mariculture should not conflict with management goals of adjacent uplands as provided by approved plans or policy of the managing agency.

7c - Mariculture caretaker facilities. Floating caretaker facilities for mariculture operations may be allowed. Floating caretaker facilities for mariculture operations will not be allowed in designated recreation or personal use areas unless a determination is made there is no feasible or prudent alternative. Determination will be made available for public comment.

7d - U.S. Coast Guard approval. Permits or leases will not be given until U.S. Coast Guard has certified that proposed facilities will not be a significant navigational hazard.

Project Design Guidelines

8. To minimize adverse impacts on productive benthic habitats:

8a - Increase distance of floating structures from shore to avoid shallow, productive habitats.

8b - In areas where potential for adverse impacts from organic sedimentation is high, minimize density of stocking and increase areal extent.

8c - Use flexible floating structures to minimize dampening action on waves and current flows (i.e., break water effects) to maintain natural circulation patterns.

9. To minimize adverse impacts of disease or toxicants on natural stocks:

9a - Avoid use of creosoted logs and pilings in structures.

9b - Avoid use of anti-fouling chemicals.

10. To minimize adverse impacts on predators or species sensitive to disturbance:

10a - Use nonlethal means of predator control.

10b - Use netting or other materials such as plywood to cover culture structures to provide a physical barrier to potential bird, mammal, and invertebrate predators.

10c - To minimize predation by waterfowl, waterbirds, and birds of prey, aquaculture operations should be covered with plywood or netting that has a mesh size small enough to prevent birds from penetrating it and is made of a gauge heavy enough to be visible to birds and to prevent them from becoming entangled in it. This guideline applies to nets used for both above water and underwater protection.

10d - Plywood or mesh covers on rearing structures should be employed to minimize attraction of bears.

10e - To prevent access by predators, use heavy gauge nets to prevent access.

10f - Operations should be designed and managed to minimize attraction of furbearers. If netting is employed, it should be of a mesh size small enough to prevent entrance and made of a gauge or material that cannot be chewed or clawed apart. Sheet metal collars should be placed on cables, boom sticks, and stiff legs attached to shore to minimize furbearer predation.

11. To minimize adverse impacts on other coastal users:

11a - The culture technique chosen can mitigate impacts on other users of the area if other users are not excluded from access to the area. Bottom culture avoids impacts to many commercial and noncommercial users of fish and wildlife resources, however harvest of bottom dwelling species may be displaced or precluded. Floating facilities are preferable to structures embedded in intertidal area. Longline culture facilities can be designed to be less visible than raft facilities, however low visibility can create navigation hazards. Longlines, by their nature, are more able to withstand rougher sea conditions than standard construction rafts and are suitable in areas of deeper water. Use of longlines provides greater siting flexibility to avoid sensitive areas or use conflicts, and may, in some cases, be a feasible and prudent alternatives to raft culture.

11b - Reduce areal extent of floating facilities to minimum size needed in areas where conflicting uses occur. Consider increasing stocking densities as a means to minimize areal extent.

11c - Provide navigation lanes or access easements through facilities.

11d - Increase distance of floating structures from shore to minimize use conflicts.

11e - Lower floating structures (e.g. nets, longlines) in the water column to avoid conflicts with navigation and recreational use of the area.

Comment: Lowering cultures, either temporarily or permanently within a range of 12 meters below the surface has also been recommended to avoid sets of fouling organisms, high surface water temperatures, rocking of scallops, and unstable salinity and temperature conditions. Growth may be reduced under these conditions, but disastrous events may also be avoided.

11f - Design size, color, and height of structures for low visibility where desirable to minimize impacts to aesthetics and where navigational hazards will not be created. Design high visibility marking devices (e.g., lighted buoys) where necessary for safe navigation.

11g - Consolidate facilities to minimize impacts on other users. However, establish separation distances between farms to minimize cumulative impacts on water quality and potential for disease transmission.

11h - Development plans. A site plan and other relevant information is requested on the Consolidated Shellfish Farm Application. An additional development plan will not usually be required. The preferred approach is for the site plan and other information to constitute a development plan to serve (at a minimum) as basis for DNR, ADF&G, DEC, ACMP, and upland owner review.

12. Upland facility sewage disposal.

12a - A sewage disposal system adequate to protect nearby shellfish from contamination will be required for any caretaker facilities associated with a mariculture operation.

Operational Guidelines

13. To minimize adverse impacts on productive benthic habitats:

13a - Set poles and anchors carefully during periods of lowest productivity.

13b - If structures (e.g., nets) are periodically removed, leave poles and anchors in place.

13c - Monitor sediment build up and impacts on substrate/water chemistry. Adjust stocking rates, remove organic deposits, or move facility if anaerobic substrate conditions are unavoidable.

13d - If herring spawn on structures, leave them in water until the spawn hatches.

14. To minimize adverse impacts on predator populations or species sensitive to disturbance:

14a - Use nonlethal predator control measures.

14b - Use nonlethal means of fouling control.

14c - Garbage should be kept to a minimum and incinerated daily. Food should be handled to prevent its odor from attracting bears and stored in bear proof containers. Disposal of shellfish by products or dead animals should be done in such a way as to minimize attraction of bears in a site approved by DEC.

14d - Remove structures during periods of conflict with species sensitive to disturbance.

Comment: This measure was identified as a mitigating measure for Nori farms in Washington (Washington DNR 1987). In a programmatic Federal Environmental Impact Statement, they identified the following mitigative measures: 1) removing all rafts when not in use for a period of one month for production, 2) removing nets not actively used for production, 3) removing nets during herring spawning season if overspawn of herring outside traditional areas was anticipated, 4) removing nets and structures in less than 10 feet of water depth between March 15 until June 15 every year to prevent impacts on juvenile salmon migration.

15. To minimize the impacts of disease, toxicants, or genetic changes on natural stocks:

15a - In the case of disease outbreaks, notify Alaska Department of Fish and Game and follow existing procedures for control of disease. Use of chemicals and disposal of diseased plants or animals must be approved by DEC.

15b - No exotic species of plants or animals can be imported without approval by Alaska Department of Fish and Game. (by law)

15c - Plants and animals shall not be transported between culture areas or from the wild to a culture situation without approval by Alaska Department of Fish and Game. (by law)

16. To minimize adverse impacts to other users:

16a - Remove structures (e.g., Nori nets) during periods of conflict with other fisheries.

16b - Restrict hours or periods of operation to daytime hours if necessary.

17 - Performance standards

DNR will attach reasonable performance standards to permits or leases for project development and operation. Performance standards are to ensure permitted area is used for the approved activity, the proposal is economically viable, and the permit or lease is

not held for speculation or removal of a land base from competition. In all cases approved development plans must be adhered to. If the performance standards are not met, the permit or lease may be revoked.

Etolin Island Area

Mariculture Pilot Project

CHAPTER 4

Project Review and Permitting

Chapter 4

PROJECT REVIEW AND PERMITTING

INTRODUCTION

Aquatic farms in marine waters and on adjacent uplands can raise public concerns about environmental and land use effects. Chapters 2 and 3 discuss these considerations for siting or operating shellfish or aquatic plant farms. State and federal agencies have authority to manage or regulate aquatic farms and to resolve or mitigate public concerns. Aquatic farmers must obtain authorizations from state and federal agencies before initiating farm-related work.

State and federal aquatic farming authorization occurs at three primary stages: 1) siting and design approvals, 2) stocking approvals, and 3) product distribution authorization. Aquatic farm siting and design involves the most significant commitment of public resources and therefore has the most specific regulatory requirements. This phase also generates the most public interest, primarily because of land use considerations necessary to properly site an aquatic farm.

All development projects occurring in the coastal zone of Alaska as established in the Alaska Coastal Management Act must undergo review to ensure their consistency with the standards of the Alaska Coastal Management Program under 6 AAC 80. Statewide standards are in effect in the Etolin Island Study Area. Different or more detailed standards may be in effect within the boundaries of coastal districts with approved coastal plans. No local coastal district has been organized in the study area. DNR, DEC, and ADF&G review mariculture projects against the coastal standards in the course of their permit review.

Authorizations for siting and design, stocking, or product distribution phases involved in aquatic farming are listed in Table 4-1. Application materials and issuing agencies are also identified in this table.

This chapter describes the state's interagency project review and authorization process used to schedule timely and thorough project discussions. Specific information about each state or federal resource agency approval required for aquatic farming is also presented.

SITING AND DESIGN PHASE

Alaska Coastal Management Program Project Review Process

As interest in developing Alaska's resources increased during the last decade, industries demanded state agencies become better organized and integrated to streamline the permitting processes for coastal project siting and design. In response to this need, and under Alaska Coastal Management Program (ACMP) authorities, the Division of Governmental Coordination (DGC), within the Office of the Governor established in regulation (6 AAC 50) a project review system that: 1) assists applicants in determining what state resource agency siting and design authorizations are necessary for coastal projects, 2) gives state resource agencies and local governments opportunity for concurrent and coordinated processing of all approvals needed to site these proposed projects, and 3) mediates any objections by applicants to proposed ACMP conditions.

The coastal project review process, also known as the consistency review process, provides a coordinated interagency review to determine project compliance with regulatory standards of the Alaska Coastal Management Program. This process is designed to concurrently allow agencies to exchange resource information and concerns related to an ACMP consistency determination and agency decisions on particular project authorizations. The consistency review process is designed to allow further refinements for specific types of coastal development projects. The Etolin Island Pilot Project provides an opportunity to present the recently developed Consolidated Shellfish Farm Application process. Additional processing improvements will also be recommended.

Aquatic farm legislation was passed (Chapter 145 SLA 88) which will affect processing of shellfish, sea vegetable, and related hatchery proposals. Implementation procedures for this legislation are being developed. These procedures must reflect the intent, incorporate the requirements of the bill and maintain the existing ACMP interagency consistency review process. (See process discussion on page 73.)

Coastal Project Questionnaire and Preapplication Services

The first step in the consistency review process is to fill out a coastal project questionnaire (CPQ), which, is designed to help applicants determine what state authorizations are necessary before project construction can begin. It also cross references related federal permit application requirements. Completed questionnaires are submitted as part of a review packet to help project reviewers understand a proposals scope. A simple yes/no question series in the CPQ has been designed by each permitting agency to identify permit requirements. A "yes" answer means that a permit for that aspect of the proposal **may** be necessary. An agency contact list is provided with each CPQ so applicants can speak to appropriate individuals about specific application requirements indicated by "yes" answers.

Before finalizing project plans and submitting applications, an applicant can request that the coordinating agency arrange meetings between applicants and state agency representatives. Preapplication meetings can help identify concerns, relay a need for more information, and encourage a mutual project understanding. Preapplication meetings can be arranged by calling or writing to the coordinating agency.

For initial aquatic farm siting and design, the coordinating agency is always DGC. Table 4-1 lists numerous state and federal permits which may be coordinated under a DGC project review. Aquatic farms in marine waters will require the following approvals (items 1-8 from Table 4-1):

1. Consistency Determination, from DGC.

2. Certification of Reasonable Assurance, issued by the Department of Environmental Conservation (DEC), to assure the project will meet state water quality standards.

3. Land Use Authorization. This permit or lease, issued by the Department of Natural Resources (DNR), conveys interest in state owned tidelands.

4. Shellfish Farm Approvals, issued by the Department of Fish and Game (ADF&G).

5. Approval by the U.S. Army Corps of Engineers to ensure the aquatic farm does not obstruct navigation.

6. For upland facilities proposed on public lands, a land use permit is required. The U.S. Forest Service is the upland land manager for the majority of public uplands in the study area.

As shown in Table 4-1, most state applications (items 1-6) can be applied for on a single Consolidated Shellfish Farm Application.

To participate in the state's project review process, an applicant must first complete a Coastal Project Questionnaire (CPQ) to determine which authorizations are needed, and then submit all necessary applications.

TABLE 4-1 PERMITS WHICH MAY BE NECESSARY FOR MARICULTURE PROJECTS

Permit/Certification	Application Materials	Issuing Agency
Siting and Design Phase		
1. Alaska Coastal Management Program Consistency Determination	Coastal Project Questionnaire Consolidated Shellfish Farm Application	Division of Governmental Coordination
2. Certificate of Reasonable Assurance	Consolidated Shellfish Farm Application Corps of Engineers Application	Dept. of Environmental Conservation
3. Tideland Use Permit/Lease	Consolidated Shellfish Farm Application	Dept. of Natural Resources
4. State Park Use Permit	Consolidated Shellfish Farm Application	Dept. of Natural Resources
5. Shellfish Farm Permit	Consolidated Shellfish Farm Application	Dept. of Fish & Game
6. Fish Habitat Permits	Consolidated Shellfish Farm Application	Dept. of Fish & Game
7. Navigation Permit	Corps of Engineers Application	U.S. Army Corps of Engineers
8. Special Use Permit for Upland Facilities	Separate Agency Application	U.S. Forest Service
9. Beachlog Salvage Permit	Separate Agency Application	Dept. of Natural Resources
10. Material Sales	Separate Agency Application	Dept. of Natural Resources
11. Water Rights (If greater than 500 gal/day)	Separate Agency Application	Dept. of Natural Resources
12. Wastewater Discharge Permit (If greater than 500 gal/day)	Separate Agency Application	Dept. of Environmental Conservation
13. Solid Waste Disposal Permit	Separate Agency Application	Dept. of Environmental Conservation
Stocking Phase		
14. Aquatic Stock Acquisition Permit	Separate Agency Application	Dept. of Fish & Game
15. Fish Transport Permit (if greater than single family use)	Separate Agency Application	Dept. of Fish & Game
Product Distribution Phase		
16. Sanitary Survey	Separate Agency Application	Dept. of Environmental Conservation
17. Shellstock Shippers Permit	Separate Agency Application	Dept. of Environmental Conservation

Consolidated Shellfish Farm Application

For a proposed shellfish farm, state authorizations listed above can be applied for by filing a single form, the Consolidated Shellfish Farm Application (CSFA) (see Appendix D).

If an aquatic farm needs an assured fresh water supply, the applicant should apply for water rights on a separate application. Applying to DNR for water rights is **required** if use will exceed 500 gallons per day. Similarly, wastewater discharge exceeding 500 gallons per day requires a permit from DEC. Applicants must also submit separate applications for purchase of state timber or gravel from DNR. These permits are not issued from CSFA forms because they are not essential for a typical aquatic farm. CSFA was limited to most frequently needed authorizations so applicants would not have to supply unnecessary information.

Project Packet

To initiate the state's coastal project review process for aquatic farm project proposals, DGC must receive the following completed packet:

1. Signed and completed Coastal Project Questionnaire.

2. Consolidated Shellfish Farm Application

3. Any state permit applications needed for the project not included in the CSFA (i.e. water right application or material sale application).

4. U.S. Army Corps of Engineers public notice (which jointly notices the state's project review)

5. Copies of any federal permit applications needed for the project (originals go the federal agency issuing the permit)

6. Additional pertinent information i.e., maps, site design sketches, and public notices from agencies.

Receipt of the project packet ensures that the state can address all administrative and regulatory siting and design matters for this project siting and design phase in one interagency review.

Project Schedule

Aquatic farm reviews are scheduled by DGC to occur within an established 50-day review schedule. This schedule begins upon receipt of a complete project packet. Chapter 145 SLA 88 requires that DNR accept the land use application for aquatic farm projects only during an annually scheduled "opening" for defined districts. Steps in the state's consistency review process are illustrated in Figure 4-1. This process will be modified to incorporate the new requirements of Chapter 145 SLA 88. DGC sets review schedules and distributes project packet information to all reviewing agency contacts and to the affected local government or coastal districts. (See AS 46.40 or 6 AAC 85 for reference to the establishment of local coastal districts under the ACMP).

Comment and decision deadlines are set to bring predictability and timeliness to the review process, to promote efficient interagency discussion and resolution of issues relating to coastal management issues. These schedules may be extended if: 1) incomplete applications result in requests for additional information 2) public hearings are conducted, and 3) resource agency field investigations are necessary.

Conflict Resolution

If a state resource agency (DNR, DEC, ADF&G), a coastal district with an approved plan, or an applicant does not agree with a proposed consistency determination and interpretation of ACMP standards, they may request elevation of the finding to division

directors for reconsideration. Further consideration by commissioners of those agencies can also be requested if new policy direction must be established. Elevation steps will be managed under an additional 15 day review schedule.

Each resource agency also has an administrative appeal process that gives any aggrieved person an opportunity to dispute that agency's action. The ultimate recourse by a person who objects to a final agency decision, including an ACMP determination, is an appeal to the Superior Court.

Public Notice Systems

The Alaska Coastal Management Program review process integrates the review of permits needed for siting and designing a routine aquatic farm. Although this system can schedule review of coastal projects by agencies and local coastal districts, this process cannot alter specific agency requirements for public notice. Individual public notice is required for land management authorizations and most regulatory approvals required for mariculture projects. Three separate public notices are generally required for proposed aquatic farm projects.

The U.S. Army, Corps of Engineers (COE) routinely issues a public notice for Section 10 or Section 404 permit applications. A notice of the state's review for ACMP consistency certification and Department of Environmental Conservation's (DEC) "Certification of Reasonable Assurance" that the project will meet the State's water quality standards is also included within public notices printed by COE.

In addition to public newspaper notice, COE sends information packets to a general mailing list. DGC also sends complete project packets to all participating state and federal agencies and to affected local coastal districts.

Public notice under AS 38.05.945 is required for all land use authorizations DNR is proposing to issue for aquatic farms and related hatcheries as a result of recent legislation (see Appendix G). DNR is working with other state resource agencies, COE, and DGC to establish procedures to enable concurrent public notice publication where possible.

Under the National Environmental Policy Act, the U.S. Forest Service is required to provide a public notice and comment period to determine issues related to any Special Use permit application. Timing of this notice is determined independent of COE or DNR notices.

Although timing of all three notices has not been determined, a probable sequence if an aquatic farmer submitted all agency applications concurrently could be: (See Figure 4-2 on next page):

1. The Forest Service would issue a notice addressing caretaker facilities for mariculture upland activities.

2. Within the same month, COE may issue a public notice for a waterborne structure. This notice would also address the state's consistency determination and DEC 401 certification.

3. Concurrent with COE notice, DGC would send a completed packet to a preestablished distribution list which includes Tongass National Forest Ranger Districts.

4. DNR may issue public notice for use of state lands at this time;

5. DNR contacts the Forest Service as upland owner for comment during consistency processes; and

6. A public notice is issued at the end of DNR's preliminary best interest finding, a procedure which follows conclusion of the consistency review.

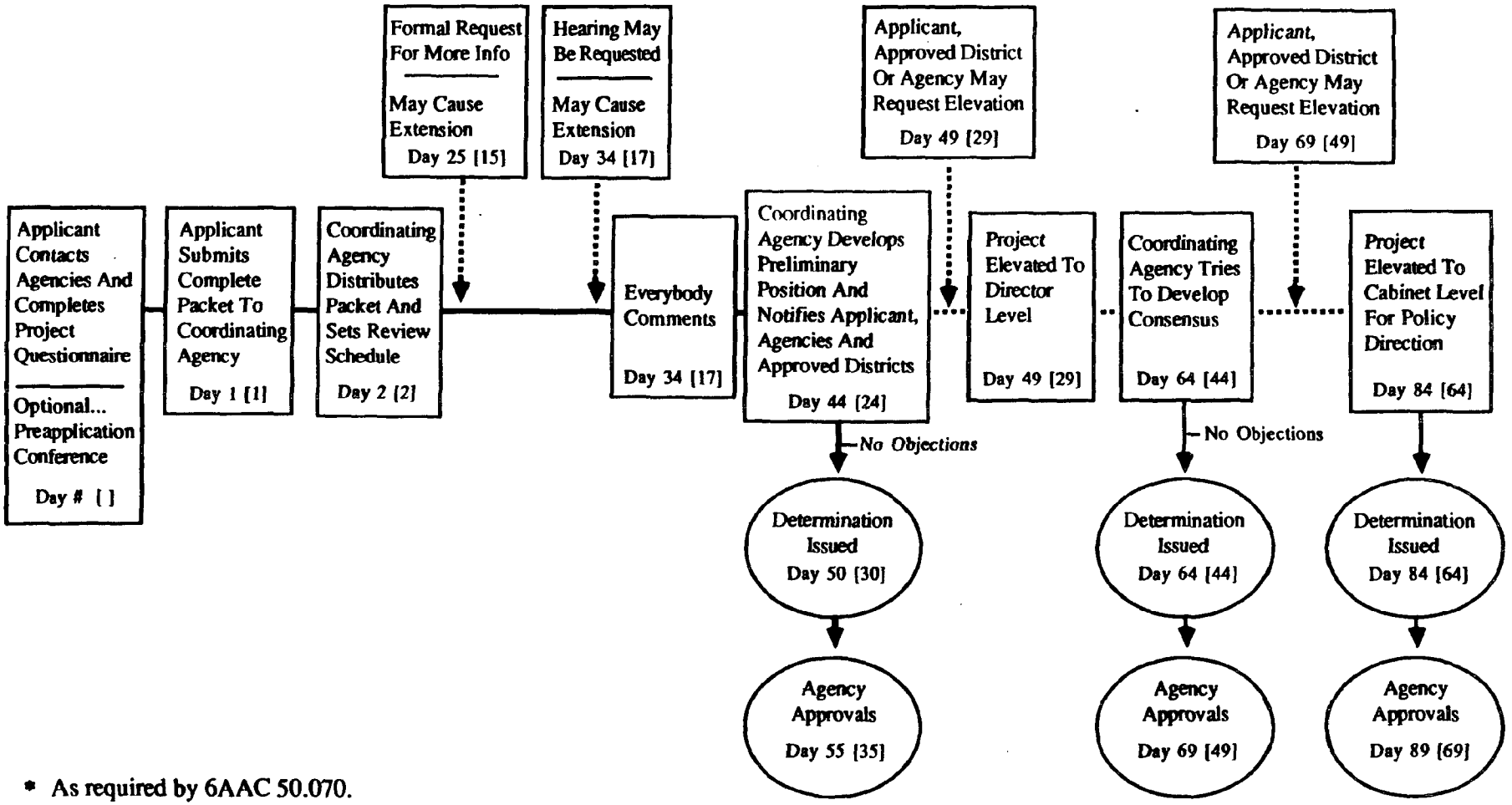
These divergent public notices result from specific agency requirements. During implementation of Chapter 145 SLA 88, the aquatic farm legislation, an effort will be made to examine and coordinate to the extent pos-

sible, public notice for all state and federal permit applications to occur jointly or concurrently.

Issuance of State Agency Permits

Under state and federal law, any resource-related permits for coastal activities must be determined to be consistent with standards of ACMP before any state or federal permits are issued. The consistency review process previously described is used to make a consistency determination, thereby finding each related permit consistent. The consistency determination is the first decision document issued in the state's project review process because it is required prior to other agency actions on coastal projects.

FIGURE 4-1 PROJECT CONSISTENCY REVIEW PROCEDURES*



* As required by 6AAC 50.070.

\# Day of review schedule on which milestone occurs.
First number is for a 50 day schedule, [#] is for 30 day schedule.

····· Optional milestone

Approvals Routinely Required for Siting Mariculture Projects

Land Management Approvals

Development on uplands and tide/submerged lands in public ownership requires approval from managing agencies prior to such activities. DNR is the primary land manager for state owned lands. The Division of Land and Water Management (DLWM) within this Department has primary responsibility for issuing the permits or leases necessary for aquatic farm development on state owned lands or waters.

Several federal agencies manage most federal lands in Alaska: U.S. Forest Service, U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, and U.S. Bureau of Indian Affairs.

The U.S. Forest Service is the responsible land management agency for all federal lands above mean high tide line within the Etolin Island project area. These lands are managed through the local Ranger District office in Wrangell.

DNR Land Use Permits and Leases

DNR currently manages approximately 85 million acres of uplands, about 10 million acres of water, and most tidelands along the State's 34,000 mile coastline. DNR also manages approximately 25-30 million acres of submerged land offshore out to the three mile territorial sea boundary.

DNR is mandated by Alaska's Constitution to encourage settlement of the state's land and development of it's resources by making them available for public use, consistent with public interest. State statutes direct departmental management of state owned land to establish a balanced land use for both public and private purposes, and to administer state programs for the conservation and development of natural resources.

New Process

Chapter 145 SLA 88 was passed in the last hours of the 15th legislature. Implementation will be designed to mesh smoothly with the existing coastal project review process to avoid duplication of effort by applicants, government agencies, and the general public interested in commenting on aquatic farm proposals.

This legislation mandates DNR to adopt new regulations. Adoption of regulations allows for public participation in making policy decisions needed to carry out the law. This section sets out major requirements of the legislation and of existing laws and regulations that generally apply to aquatic farm development.

Under the aquatic farm legislation, DNR begins the process of authorizing new aquatic farms by identifying geographic districts within which it will invite site applications. Any person who wants to obtain permits to develop an aquatic farm on state owned tidelands may participate. The application period for aquatic farm permits will remain open for at least 60 days each year. In line with current agency practice, the application will probably be a consolidated form that provides information other state agencies will need to process their own permits. The applicant will fill out a CPQ and submit applications for any necessary federal permits at the same time.

After consultation with ADF&G and DEC, DNR will prepare a preliminary finding under AS 38.05.035 (e) explaining why it believes it is in the state's best interests to grant permits for aquatic farm development at particular sites. Conversely, if DNR believes a permit should **not** be issued for a certain site, it will give the applicant a written finding explaining reasons for denial. DNR must prepare land use plans and classification orders for proposed sites that are not classified. Agencies are developing procedures to incorporate classification requirement into the consistency review process.

DNR will hold a public hearing in each district where it proposes to issue aquatic farm permits. It will give public notice under AS 38.05.945, including advertisements in local and statewide newspapers and notice to affected municipal governments or Native regional corporations, regional fish and game advisory councils, coastal resource service areas (local councils authorized to prepare district coastal management plans where there is no municipal government to do so) and others, inviting interested people to testify or to comment in writing on the proposal.

After considering comments it has received, DNR will prepare a final finding on the proposed permit sites, while DGC issues a conclusive (final) consistency determination. If a proposal is determined to be consistent with ACMP and to be in the state's best interests, an aquatic farm permit will be granted. Other agencies will take similar action under their own statutory authorities.

Tideland Permits

An aquatic farm permit is a nontransferable right, valid for three years, to enter, improve, and develop a state tidelands site into an aquatic farm or hatchery. The permittee must post a bond or other security to cover restoration costs if the site is later abandoned. DNR has the discretion to renew permits, but must again give public notice and consider comment received before doing so. If the permittee succeeds in developing the site for aquatic farming or as a hatchery and the site is offered for lease, the permittee has first rights to that lease (see below).

Leases

As with other leases issued for state owned land, aquatic farm leases may be assigned (transferred) with the approval of DNR. If the assignee changes use of the site, the lease reverts to the state. Leases are long term property rights: their duration can be as much as 55 years, although the department will probably choose a shorter term (10 to 25 years). If a permittee who developed a site for aquatic farming chooses not to lease it, the lease will be offered to the public. Sites will be leased for not less than their appraised fair market value. The lease will be reappraised and rent adjusted accordingly every five years. The lessee must post a bond or provide other security to cover restoration costs if the site is later abandoned.

Other DNR Approvals

To develop an aquatic farm an applicant may need other authorizations from DNR. A person may obtain ownership of beach logs to be used for construction of rafts by purchasing a beach log salvage permit. This permit is administered through DNR's Division of Forestry. A water appropriation may be obtained from DNR's Land and Water Management Division, giving the aquatic farm developer legal right to continue using a particular quantity of fresh water. Water rights are normally transferred with the permit or lease they serve.

Materials (sand or gravel) on state uplands or tidelands may be purchased from the DLWM to use for fill or other purposes. Materials are sold at fair market value.

If an aquatic farm is proposed within a State Marine Park (none in the Etolin study area) authorization from the DNR, Division of Parks and Outdoor Recreation is required.

U.S. Forest Service Land Use Permits (Special Use Permits)

The Tongass Land Management Plan provides broad direction for all activities, including aquatic farming, occurring on the Tongass National Forest. The forest includes most land above mean high tide line. The Tongass Land Management Plan has allocated the study area for the Etolin Island Area Mariculture Pilot Project to a mixture of land use designations. Each land use designation allows a given range of activities to occur within the land unit. Management objectives of land use designations are presented in Chapter 3. The Etolin Island Project map (in-

side back cover) delineates land use designations for this area of Tongass National Forest. Some land around Olive Cove on the east side of Etolin Island is either privately or state owned so direction from the Tongass Land Management Plan does not apply.

Any use of federal lands for development requires a Special Use Permit. This may include needs for shoreties, storage facilities, living facilities, water lines, and communications equipment. Special Use Permits are usually issued annually and a require a fee. Forest Service reviews and decisions about upland facilities for mariculture proposals should occur at the same time the state's project review and COE permit review are occurring.

The U.S. Forest Service approval of permit requests will depend upon whether or not the need for upland facilities can be accommodated on the tideland permitted area, or if there are state or private lands in the vicinity that are suitable. Impacts on surrounding environment are evaluated. Apparent suitability of tideland sites for mariculture purposes is also a determining factor. Compatibility with laws, regulations, land use designations and other projected uses are evaluated. Public project review occurs in accordance with the National Environmental Policy Act (NEPA).

NEPA Processes

The determination of permit suitability will be accomplished by following procedures required in the National Environmental Policy Act (NEPA). This document is the basic national charter for environmental protection, establishing policy, setting goals and providing a means for policy implementation.

NEPA procedures ensure environmental information is available to public officials and citizens **before** any action is taken.

All sites requested for permits will be examined, usually by an interdisciplinary team (IDT) and they will evaluate the project or facility in relation to its surrounding environment. This evaluation will then be made available for public review.

Other Mariculture Project Regulatory Approvals

In addition to approvals for access and use of public lands, a significant regulatory structure is in place to address public issues related to the impact of uses related to aquatic farming. These additional public interest considerations are administered through state and federal regulatory agencies as follows:

Department Of Environmental Conservation Approvals

DEC has two divisions involved in permits and certifications necessary for development of aquatic farms. The Division of Environmental Health (DEH) and Division of Environmental Quality (DEQ). The Division of Environmental Health (DEH) has two major mariculture responsibilities. One is to conduct sanitary surveys and certify sites for growing commercial shellfish. This is in compliance with the National Shellfish Sanitation Program. The second responsibility of DEH is product certification prior to marketing. Authorization occurs with issuance of a Shellstock Shippers Permit. This ensures a product free from PSP and other contaminants. Those certifications are described later in this chapter.

Both of these certifications are conducted independent of an ACMP review and outside the ACMP time frame. However, during the project siting and design phase, Divison of Enviornmental Quality (DEQ), who does participate in the ACMP review process, will notify DEH of a mariculture proposal. DEH will contact the applicant with information about requirements for the growing site to be certified and to initiate shellfish product commercial sales.

DEQ is responsible for regulating water quality in Alaska. Water Quality Standard Regulations, 18 AAC 70, are guidelines which

regulate water pollution. Specific water quality parameters for each designated water use are addressed in the Water Quality Standards section of Chapter 3. For fresh and marine waters these include: fecal coliform bacteria, dissolved oxygen, pH, turbidity, temperature, dissolved inorganic substances, sediment, toxic and other deleterious organic and inorganic substances, color, petroleum hydrocarbons, oils and grease, radioactivity, total residual chlorine and other residues. DEC uses the following procedures to apply appropriate water quality criteria for any water body:

1. If a water body is protected for more than one use class the most stringent water quality criteria will apply.

2. At the boundary between waters protected for different use classes the most stringent use class will apply.

3. In estuaries, where fresh and marine water quality criteria differ within same use classes, the standard will be determined on the basis of salinity. However marine water quality criteria will apply for dissolved oxygen if salinity is one part per thousand or greater and for fecal coliform bacteria if salinity is 10 parts per thousand or greater.

Water Quality Standards apply to siting and operation of mariculture facilities. DEQ is responsible for issuing the Certificate of Reasonable Assurance required under section 401 of the Federal Water Pollution Control Act Amendments of 1972, as modified by the Federal Clear Water Act of 1987. Under section 401 any applicant for a federal license or permit to conduct any activity which may result in any discharge into navigable waters of the state must obtain certification from the designated state agency to assure such discharge will comply with State Water Quality Standards. DEQ also reviews plans for sewage systems and applications for wastewater discharge and solid waste disposal permits, if needed. A description of each of these approvals follows.

18 AAC 70.010 states no person may conduct an operation that causes or contributes to a violation of the Water Quality Standards. Water Quality Standards establish various protected water use classes and criteria. Water quality standards set by 18 AAC 70.010 specify the degree of degradation that may not be exceeded in a water body as a result of human actions. All water bodies that are naturally of higher quality than water quality criteria for that use class must be maintained at the existing quality. An applicant may apply for a short term variance that would allow Water Quality Standards to be violated for a predetermined temporary period of time. It is also possible to petition for a reclassification of the water body to a less stringent use class.

Section 18 AAC 70.020 sets out specific water quality criteria that must be maintained in various water use classes. These classes are separated into marine and fresh water uses and include such things as water supplies, water recreation, growth and propagation of fish, shellfish, and other aquatic life and wildlife.

401 Certification

As part of the responsibilities for regulating water quality, the Division of Environmental Quality (DEQ) must issue a Certificate of Reasonable Assurance that a mariculture project will, during construction and any time afterward, be consistent with state water quality standards. This certification is made concurrently with the ACMP review. The time frame is the same as that for an ACMP review.

401 certification is required by COE before they will issue a COE permit for structures in navigable waters or to place fill in wetlands. Any stipulations attached to 401 certifications will be attached and become part of the COE Permit.

Under 401 review, DEQ looks at any impacts a mariculture development might have on surrounding waters. This could include discharge of organic materials from the animals,

or addition of any substances into the water by the farmer. Projects will also be reviewed for possible conflicts with other waters uses in the project area. Where appropriate, mitigating measures may be stipulated.

During 401 reviews it is important that activities associated with caretaker support facilities are clearly defined. All information on storage of hazardous chemicals and sewage treatment needs to be provided. Lack of this information can slow down the review process.

Wastewater Discharge and Solid Waste Permits, System Plan Reviews

DEQ regulates all discharges including: sewage, gray water, and nondomestic (commercial or industrial) wastewater discharges associated with, or affecting, mariculture facilities.

Wastewater Disposal Regulations, 18 AAC 72, establish treatment and disposal requirements for domestic and nondomestic sewage and gray water. Wastewater regulations define minimum levels of treatment. They also define: discharges exempt from needing waste disposal permits; discharges exempt from plan review requirements; criteria for design of wastewater systems, including separation distances and minimum treatments; criteria for plan approval of wastewater systems; and criteria for subdivision plan approval.

The two main regulatory procedures for disposal of wastewater are a wastewater permit and a system plan review. Under 18 AAC 72, Wastewater Disposal Regulations, a person who disposes of domestic wastewater into or onto waters or lands of the state must have a waste disposal permit unless discharge is to a soil absorption system, or is no more than 500 gallons per day, and which meets minimum treatment and system plan review requirements.

Normal treatment for domestic wastewater is secondary treatment. For discharges into marine waters, DEC may grant a waiver down to primary treatment. Domestic wastewater includes gray water, which is defined as wastewater from laundry, kitchen sinks, showers, baths, or other domestic sources. A person who disposes of nondomestic wastewater into or onto waters or lands of the state must have a waste disposal permit.

For wastewater discharges under 500 gallons a day no permit is issued and the DEC completes only a system plan review. Under 18 AAC 72, a system plan review is not required for single family dwellings using an on site domestic wastewater disposal system meeting requirements of wastewater disposal regulations. A system plan review is required for single family dwellings discharging treated wastewater onto land or into state surface waters and for all wastewater systems that are larger than single family facilities, and all commercial/industrial facilities.

Subdivision plan reviews are also regulated under 18 AAC 72. DEC reviews all property subdivisions of two or more parcels. The review determines types of sewage disposal systems, if any, feasible on the parcels. Department conditions may be placed on the plat limiting the types of wastewater disposal system allowed. Treatment systems that will discharge into water will also need further plan review by DEC. An individual lot owner may propose some type of sewage disposal system, other than the type of system approved for subdivisions, by submitting plans for an alternative system. DEC will review plans for conformance with wastewater regulation and approve, conditionally approve, or deny plan approval.

The purpose of Solid Waste Disposal permits is to control or eliminate detrimental health, environmental, and nuisance effects of improper solid waste disposal practices. A person who constructs, modifies, or operates a solid waste disposal site must do so in accordance with regulations in 18 AAC 60, which pertain to solid waste management. A permit is not required for a single family or duplex residence on a farm where solid waste is generated and disposed of on the premises. "Solid waste" means garbage, refuse, sludge and other discarded material including solid,

liquid, semisolid or contained gaseous material resulting from industrial, commercial and agricultural operations, and from community activities.

Department Of Fish And Game Approvals

Alaska Department of Fish and Game (ADF&G) has broad responsibilities to "manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and well being of the state". (AS 16.05.020). Because for-profit mariculture currently involves private ownership of cultured shellfish, ADF&G reviews proposed activities primarily to determine the effects activities will have on state owned fish and wildlife resources and their yields or harvests. In addition, ADF&G is statutorily mandated to "encourage the investment by private enterprise in the technological development and economic utilization of the fisheries resources" and to "... do all things necessary to insure perpetual and increasing production and use of the food resources of Alaska waters..." (AS 16.05.092) ADF&G regulates shellfish mariculture activities in three ways:

1. Through technical review and permitting of proposed shellfish farms. Permits related to technical review of mariculture farm proposals are discussed below.

2. Through issuance of permits for transportation, possession, and release of live fish including exportation or importation of shellfish.

3. Through issuance of interim-use permits for harvest of larval and juvenile shellfish.

Shellfish Farm Permit

The Fisheries Rehabilitation, Enhancement, and Development Division (FRED) of ADF&G has primary responsibility for review and issuance of Shellfish Farm permits. Applications are evaluated to determine that: 1) physical and biological characteristics of proposed locations are suitable for a shellfish farm, 2) proposed farms do not unreasonably or adversely affect management of natural stocks or require significant alterations in existing uses of fish and wildlife resources, 3) farms will not adversely affect fisheries, wildlife, or their habitats, and 4) plans for operation and staffing demonstrate adequate technical and operational feasibility.

Title 16 Permits

The ADF&G Habitat Division has primary responsibility for reviewing applications and issuing permits for use of fish habitat under Title 16. These permits are required by ADF&G for activities which affect streams, through blockage of fish passages or through a variety of activities, such as water usage, flow diversion or obstruction, pollution, or use of equipment in stream beds that may cause adverse impacts to anadromous fish habitat. Water use for upland facilities or operations and culvert or bridge installation in streams during road construction are types of mariculture activities that may require Title 16 permits. Special area permits are also required by ADF&G for land use activities in legislatively designated state game refuges, sanctuaries, and critical habitat areas.

Under a broad mandate of the Fish and Wildlife Coordination Act, ADF&G reviews COE permits to provide recommendations concerning fish and wildlife resource protection.

U.S. Army Corps of Engineers Approvals

U.S. Army Corps of Engineers (COE) administers Section 10 of the Rivers and Harbors Act of 1899. This law applies in all navigable waters of the United States. It prohibits unreasonable obstructions or use of the nation's waters. Navigability issues address uses of the entire surface and bed of all water bodies subject to tidal action that lie below mean high tide, and all ocean and coastal waters extending seaward from the

coastline (mean low tide) or a distance of three geographic or nautical miles.

The COE also administers Section 404 of the Clean Water Act which regulates discharge of dredged or fill material in United States waters (including wetlands).

Section 10 and Section 404 Permits

Mariculture activity requires a COE permit for construction of any structure in or over any navigable water of the United States, and accomplishment of any other work affecting course, location, condition, or capacity of such waters. If upland or shoreline work associated with facilities requires placement of dredged or fill materials into waters or wetlands, a COE permit under Section 404 is also required.

The COE processes mariculture permit reviews by issuing a public notice for a 30-day permit. A full review allows the general public, state, and federal agencies to formulate responses within this time frame. If there are no objections, a permit will be issued by the COE satisfying Section 10 of the Rivers and Harbors Act and/or Section 404 requirements. If there are objections, the applicant must resolve them before the COE will issue a permit. If the project appears to have unresolvable aspects, Corps of Engineers will determine if it is in the public's best interest to issue the permit over objections of the reviewer. Permit issuance is a broad public interest determination. It is based on evaluation of probable impacts of a proposed activity, intended use, public interest, including conservation, fish, wildlife, economics, water quality, recreation and general environmental concerns.

Issuance of a COE permit requires the project be constructed within three years. Once this requirement is met the COE permit will be valid for the life of the project. If design or operation of the project changes a permit modification is necessary. A complete project modification review must occur prior to instituting any changes in a COE permit.

STOCKING PHASE

Collection and transport of brood stock for mariculture operations is managed solely by ADF&G. Consistency review requirements, as noted by their absence in Table 4-1, do not apply.

Fish Transport Permit

Fish Transport Permits are required by ADF&G without which "no person may transport, possess, export from the state, or release into waters of the state any live fish. In this instance, fish means any species of aquatic finfish, invertebrate or live amphibian, in any stage of its life cycle, found in or introduced into the state." Importation of live fish is also addressed in these regulations. The only fish that may be imported into Alaska for rearing or release into Alaskan waters are oysters originating from locations other than Korea, the Gulf of Mexico, and the Atlantic coast of North America. Before transport a disease history of the specific stock of fish to be transported must be established through inspection and certification by ADF&G fish pathology section. Fish Transport Permits are multiple year permits that allow ADF&G to monitor pathological and genetic considerations of stocks used in mariculture operations in the state.

A separate Fish Transport Permit form must be completed for spat collection operations and to obtain and possess shellfish for farming. Collected spat may be staged, prior to transport, in a central location specified on the permit. A Fish Transport Permit for spat collection allows only temporary possession, limited to 90 days. A Fish Transport Permit must be filled out by the buyer for each transport of shellfish from the staging area to the shellfish farm. The same is true for importation of live oysters and any subsequent movement of them between farms. Fish Transport Permits are exempt from ACMP consistency review permit review. The time frame for issuance is 45 days.

Aquatic Stock Acquisition Permit

Recently passed legislation included provisions for issuance of an aquatic stock acquisition permit to obtain seed stock from the wild for shellfish and sea vegetable farms. Unless sustained yield of the species in question would be impaired, established uses of that species unreasonably disrupted, or a Board of Fisheries regulation contravened, a permit to obtain wild stock will be issued to persons holding valid Aquatic Farm Permits. The aquatic stock acquisition permit is intended to supply wild stock if necessary to (1) meet the initial needs of a farm or hatchery; (2) if there are technological limitations on propagating cultured stock; (3) if wild stock is not being fully used; and (4) if wild stock is needed to maintain the gene pool of a hatchery or farm.

PRODUCT DISTRIBUTION PHASE

Development of shellfish farms and shellfish marketing are governed by regulations established in Article II of the State of Alaska Fish Inspection Regulations, 18 AAC 34. These regulations require an annual permit be obtained in order to harvest, process, pack, repack, sell, or possess shellfish for sale. Before a permit is issued, growing areas must be certified by DEC, Division of Environmental Health,(EH).

National Shellfish Sanitation Program

Article II of the State of Alaska Fish Inspection Regulations,
18 AAC 34, adopts the National Shellfish Sanitation Program (NSSP) Manual of Operations, Part I and II, which includes standards for sanitation, harvesting, handling, shucking and shipping of fresh or frozen shellfish. An overview of the NSSP is given in the following paragraphs.

In 1925, the National Shellfish Sanitation Program was developed from public health principles and program controls that were created as a result of concerns over the sanitary quality of shellfish shipped in interstate commerce. Control of the program was originally given to the Public Health Service, but is now administered by the Food and Drug Administration (FDA), and is dependent upon the cooperative and voluntary efforts of the FDA, the state regulatory agencies, and the shellfish industry.

In order to carry out this cooperative control program, each party accepted responsibility for certain procedures, as outlined below.

Procedures to be Followed by the State:

Each shellfish shipping State adopts adequate laws and regulations for sanitary control of the shellfish industry to insure that shellfish reaching the consumer are grown, harvested, and processed in a sanitary manner. Numbered certificates are issued annually to interstate shellfish shippers who comply with the sanitary operating standards, and copies of the certificates are forwarded to FDA.

Maximum standards for water quality, microbiological levels in shellfish, and paralytic shellfish poison (PSP) toxins were established by the NSSP and are regulated by the State. Any shellfish or growing area that does not meet these standards is in violation of the NSSP, and the product may not be marketed.
It is the responsibility of the State to use its regulatory authority to classify all coastal waters for shellfish harvesting on the basis of sanitary quality; regulate the harvesting of the shellfish; prosecute persons harvesting shellfish from restricted, prohibited, or nonapproved areas for sale; regulate and supervise the shipment and storage of shellstock, and the shucking, packing, and repacking of shellfish; conduct laboratory examinations of shellfish from particular areas; and suspend interstate shipper certificates during public health emergencies.

Procedures to be Followed by the Food and Drug Administration:

The FDA makes an annual review of each State's control program, which includes inspecting a representative number of shellfish processing plants. On the basis of the information obtained, FDA determines the degree of conformity the State shellfish program has with the NSSP. A monthly list of valid interstate shellfish shipper certificates is published by FDA and is available to State agencies and individuals upon request.

Procedures to be Followed by the Industry:

The shellfish industry cooperates by obtaining shellfish from approved sources, by processing in facilities which meet the sanitary operating standards, by placing the proper certificate number on each package of shellfish, and by keeping and making available to regulatory authorities records which show the origin and distribution of all shellfish.

The NSSP Manual of Operation:

The NSSP created a two part manual which deals with the sanitation of the growing, harvesting, processing, and distribution of shellfish. The manual is used as a guide by States in developing their shellfish sanitation laws. It is intended that States participating in the NSSP will follow the manual in exercising sanitary supervision over harvesting, shucking, packing, repacking, and reshipping of shellfish, and in issuing interstate shellfish shipper certificates.

This manual is also followed by the shellfish industry in developing and maintaining proper sanitary operating conditions while harvesting, processing, and distributing shellfish.

Site Certification and Development

The main goal of the Seafood Section is to ensure production of safe and wholesome mariculture products. This is done through a shellfish site certification and processing inspection program that meets requirements of the Federal Food and Drug Administration. Under this program, all shellfish growing areas in Alaska must be certified. Harvesters and processors must be permitted by the DEC.

During project siting and design phase, EQ will notify EH of a mariculture proposal. EH will contact the applicant with information about requirements for growing site certification and permission to initiate shellfish product commercial sales.

A sanitary survey of each proposed site is conducted by personnel from DEC prior to any harvest of shellfish. This survey is composed of two parts, with the first part consisting of water sampling and testing in the area to determine water quality, and the second part consisting of a shoreline investigation to identify any sources of pollution that may affect the area.

To determine acceptable water quality at the proposed site, water samples are usually collected from five representative sampling stations throughout the growing area. A minimum of 10 to 15 water samples are collected per station during the worst pollution conditions. These water samples are taken over a five day period at both high and low tides. Additionally, native shellfish species, including clams and mussels, are taken for PSP testing.

The shoreline investigation consists of identifying all sources of pollution, such as nearby operating industries, development on adjacent properties or waters, boat harborage, marine traffic, and incoming streams. At this time, additional sampling may be done for specific laboratory tests to evaluate sewage, oil, heavy metals, or pesticide contamination. Standard measurements of oceanographic variables such as pH, salinity, temperature, and water clarity are also done. DEC evaluates laboratory results and determines if the area can be certified.

Costs related to area certification are charged to the individual making the request and include: 1) costs of submitting samples to DEC Palmer Lab, 2) transportation costs of DEC personnel to the site from the nearest town or city which has a commercial airport, 3) providing a boat for sampling and investigation work. If aircraft is provided, the airplane must be adequately covered with required insurance. Boats which are provided must be adequate for weather conditions, Coast Guard approved, and it must have a radio and basic tool supply for maintenance. Samples are current-

ly analyzed free of charge by the DEC Palmer Lab.

Because of limited personnel and time, growers are advised to contact DEC Anchorage office at least six months in advance of their proposed harvest date to schedule their growing site sanitary survey.

Product Certification Prior to Marketing

DEC also tests and approves products prior to market. The initial step, assuming the growing site is certified, is to file an application for a DEC Shellstock Shippers Permit. This process should begin several months before the grower expects to ship any shellfish.

Applications must include the following:

1. A description of locations where the shellfish will be grown.

2. A sketch drawn to scale showing location of any structures. This should include a shorebase plant with refrigeration or equivalent, where shellstock will be held and packaged.

3. Labeling information for the shellfish product must include a waterproof and durable tag or label and must contain the AK# (to be issued), weight, type of shellfish, a "Keep Refrigerated" or "Keep Frozen" statement, specific area of harvest, date of harvest or code, and name and address of buyer and seller.

4. Cleaning and sanitizing procedures used for containers in which shellfish will be transported.

5. Documentation format for records of shellfish transported or sold; these records must be kept in a bound ledger book.

DEC recommends applications be submitted at least 90 days before project initiation to ensure adequate time for the review process.

CONSOLIDATED SHELLFISH FARM APPLICATION EVALUATION

The Consolidated Shellfish Farm Application (CSFA) is used to apply for most permits routinely required by the state to develop mariculture facilities. The application was developed by an interagency working group consisting of representatives from all state resource agencies responsible for issuing approvals for mariculture projects. This state application form is used to process the state permits most frequently needed for mariculture developments. The CFSA must be supplemented with applications for additional permits if an aquatic farm proposal includes unique requests for uses of state resources or other regulated activities (See Table 4-1).

As shown on Table 4-1, the following permits and certifications are issued from the Consolidated Shellfish Farm Applications:

- Alaska Coastal Management Program consistency determination.
- Land use authorizations from the Department of Natural Resources.
- Shellfish Farm approvals issued by Department of Fish and Game.
- Certificate of Reasonable Assurance issued by the Department of Environmental Conservation.
- Title 16 permit issued by the Department of Fish and Game
- Special Park Use permit issued by the Department of Natural Resources.

As discussed, an aquatic farmer will need to submit additional applications for other unique uses, and activities such as:

1. For an assured fresh water supply, an application to DNR for water rights may be required.

2. For wastewater discharges exceeding 500 gallons a day, a permit from DEC is required. A Solid Waste Disposal Permit is necessary for disposal of solid wastes in amounts exceeding simple family use.

3. DNR permits are required if an applicant wishes to use state timber, gravel or logs salvaged from beaches.

Detailed information is often unavailable to resource agencies evaluating proposed mariculture sites. Obtaining sufficient on-site information can be time consuming and expensive. Detailed resource information from site investigations must be provided by applicants.

In areas covered by land use plans, land classifications are assigned to specific areas which aid land managers in determining allowable uses. Information is requested from prospective aquatic farmers on the application to assist the state resource agencies in evaluating farm proposals and to focus the applicants attention on important site criteria.

While much information exists on mariculture development worldwide, a limited amount of information is available specifically for Alaska. As mariculture industries grow in Alaska, more data will be generated and add to the somewhat limited capability information available at the present time. New annual reporting requirements will provide a mechanism to correlate information on site capability parameters and production. Information gathered annually at each farm site will provide a valuable data base that both resource agencies and applicants will be able to use to extrapolate Alaska specific criteria for optimum site operations.

Concerns have been expressed by permitting agencies and by industry representatives that "speculation" could keep potentially productive sites from legitimate farming activities.

Issuing mariculture permits to those who seek wilderness cabin sites, or hope to benefit financially by selling or trading land use rights or other forms of speculation would be detrimental to the legitimate interests of the state and the mariculture industry. Under the aquatic farm legislation Chapter 145 SLA 88 a three year aquatic farm tideland use permit will be issued prior to a lease commitment to allow farmers a time frame to install facilities and begin operations according to the development plan required in the CSFA.

Continuing ADF&G and DNR aquatic farm permits and/or leases will be dependent upon a development plan as outlined by information obtained in the CSFA and by demonstrated results described in the annual report. Development proposals need to be sufficiently described in the application to present a clear picture of expected farm growth and development. Permits or leases will not be issued to individuals who do not demonstrate good faith in following proposals outlined in the CSFA without good reason.

The CSFA is a major improvement over prior applications and reflects genuine agency effort to :

- Simplify the application process for applicants,
- Consolidate information for agencies,
- Reduce paperwork.
- Addition of an annual report requirement by ADF&G

Comments

The Etolin Island Area Mariculture Pilot Project work plan outlined the need for field evaluation of the CSFA. Project participants traveled to the study area in April of 1988 to perform a number of field investigations including evaluating the CSFA. Approximately eight aquatic farms were visited and the application was filled out for each farm by agency people.

The following are comments evaluating the required questions on the application regarding specific capability and suitability information that project reviewers and aquatic farmers need in order to adequately review new proposals.

1. Pollution source information requests are minimal. The applicant is asked to determine which types of activities may have polluted the site. Agencies are unlikely to maintain comprehensive databases on past and existing point sources. While sanitation surveys by DEC will ensure polluted products will not be marketed, the potential exists for sites to be permitted and developed at the risk of considerable time and effort only to be refused authorizations required for marketing products. Although the cover letter to the applicant discusses this DEC requirement a sentence added to the " Note to Applicant" under the water quality section indicating that a site must pass the Grower Site Certification prior to marketing seafood products. This additional reference would emphasize the necessity of investigating pollution sources early.

2. Information on stocking density is not required on this application, a variable which can greatly affect areal extent of sedimentation. An estimation of proposed stocking density for the operation is provided by jointly assessing the production goals to the production facility dimension. However, a more defined stocking density figure could be easily presented by the applicant that would enable reviewers to assess environmental impacts.

3. Project reviewers must rely on descriptions of tidal flushing, information on surface tidal currents at maximum flow, water depth under floating facilities, and bottom type composition to indirectly assess the likelihood of sediment accumulation and the type of benthic community subject to impact. Nautical charts or USGS map bases may not provide adequate shoreline and tidal detail. Because aquatic farmers will out of necessity gain information on current and tide patterns and on the location of shallow sills, shelves, and rocks, more detailed information could be requested on the application to enable a more complete and thorough review during this initial siting stage.

Summary

The Consolidated Shellfish Farm Application represents a major improvement in the aquatic farm permitting and review processes. Consolidation of information requests simplifies the application process for permits most commonly issued for mariculture development. The CSFA reflects a genuine agency effort to achieve a balance between having applicants provide adequate information to equip agencies to make reasonable permit decisions distinct from the annual reporting detail which will provide a basis for refining the generalized knowledge of mariculture for Alaska specific conditions.

Better defined policies based on legislative mandates, administrative guidelines, and information gained by correlating detailed site characteristics to productivity, as reported in the annual report, will continue to provide more specific guidelines to resource agencies and application requirements to the mariculture industry. It is expected the application will undergo revisions as actual use demonstrates how adequate and appropriate questions are based on the direction provided by policies developed after the review of actual farm reports.

Annual Reports

The Department of Fish and Game requires that a person who holds a permit for a shellfish farm submit an annual report no later than December 15. During evaluation of the CSFA, resource agencies developed the following list of site characteristics which determine a site's capability to be utilized for aquatic farm purposes and its suitability to be occupied by mariculture operations from an impact standpoint. Although it is known that these characteristics are critical to farming success they have not been researched sufficiently in Alaska to set exact parameters or to require applicants to describe them in their applications.

These characteristics would best be obtained from aquatic farmers through the annual report and this will enable ADF&G to develop a data base of comprehensive site information.

Site Capability/Production/Physical and Biological Characteristics:

- Water Column Profiles (salinity, temperature, dissolved oxygen, biological oxygen demand, ph, depth of light extinction, water color, turbidity, suspended and settleable solids, conductivity) with a specified sampling schedule
- Frequency/occurrence of summer mixed water column conditions and phytoplankton blooms
- Chlorophyll production
- Abundance and size distribution of phytoplankton (specified sampling schedule)
- Presence/relative densities of indicator organisms or fouling organisms

Site Capability/Marketability:

- Fecal Coliform Concentrations
- PSP Concentrations

Site Suitability/Significant Adverse Impacts to Fish, Wildlife, or their Habitats:

- Summer water column profiles and frequency/duration of thermal stratification
- Presence/proximity of potential predators
- Degree of protection from prevailing winds
- Distribution/relative abundance of epibethic species below raft locations
- Presence/absence of benthic algae below raft locations
- Benthic infauna (species, relative densities) below raft locations

Results of Sediment Core Samples: Presence/Absence of Anaerobic Sediments

More specific information re: potential for tidal flushing: size of waterbody, location of facility with respect to restrictions to circulation and/or freshwater and marine water conditions, tidal regimes (do approaches go dry at any tidal stage?), sills

Suitability of Shoreline for Upland Development::

absence of eelgrass beds, bald eagle nests, intertidal substrate and beach fringe vegetation

Etolin Island Area

Mariculture Pilot Project

CHAPTER 5

Implementation Options, Recommendations & Summary of Public Comment

Chapter 5

IMPLEMENTATION OPTIONS, RECOMMENDATIONS AND SUMMARY OF PUBLIC COMMENT

IMPLEMENTATION

Federal and state agencies review proposed mariculture projects to ensure compliance with applicable regulations and agency management policies. Agencies participating in this project are concerned primarily with effects proposed waterborne and upland mariculture facilities would have on environmental resources, such as water quality and fish and wildlife habitat; and compatibility with other existing and planned uses of proposed mariculture sites.

Initially, Option 1, Use of Existing Project Review Procedures will be used to implement the results of this project. This report will be used informally by agencies during the review of proposed mariculture projects.

Implementation Options:

Option 1: Use of Existing Project Review Procedures

A coordinated permit review process is currently in place among state resource agencies (DEC, ADF&G, and DNR). This process, known as the consistency review process, provides for a coordinated review of projects to determine compliance with standards of the Alaska Coastal Management Program (ACMP). State resource agencies review proposed projects against their own agency requirements at the same time they review projects for consistency with ACMP. This consistency review process is coordinated by the state Division of Governmental Coordination (DGC). A complete description of the consistency review process appears in Chapter 4. Chapter 4 also describes how the U.S. Forest Service and the U.S. Army Corps of Engineer (COE) review of mariculture development could be coordinated with the state's consistency review process.

Participating agencies could use recommendations in this section as part of their existing project review procedures. Mariculture projects will be reviewed based on ACMP standards and other agency regulations. However, information and recommendations included in this study would be used as a guide to evaluate proposed mariculture projects against these enforceable standards.

Option 2: Adoption of an ACMP Mariculture Standard

All projects proposed within Alaska's coastal area must be evaluated against ACMP standards. Projects must be consistent with these standards, or they cannot be approved by state or federal agencies. ACMP standards are general policies guiding various kinds of coastal development, such as energy facilities, timber harvest and processing, and mining.

Recommendations in this study could be used as a basis for developing a new ACMP standard for mariculture development. A new standard would require public and agency review, and approval by the state Coastal

Policy Council (CPC). Once approved, the standard would apply to all mariculture development proposed within Alaska. A new standard would be implemented through existing consistency review process described in Chapter 4.

Option 3: Adoption of an AMSA Plan

Some coastal areas merit special attention because they possess unique aesthetic, ecological, recreational, geophysical, or industrial values or combinations of these values. Under the ACMP, such areas may be designated as Areas Which Merit Special Attention (AMSA). The Alaska Coastal Management Act defines an AMSA as "...a delineated geographic area within the coastal area which is sensitive to change or alteration and which because of plans or commitments or because a claim on the resources within the area delineated would preclude subsequent use of the resources to a conflicting or incompatible use, warrants special management attention, or which, because of its value to the general public, should be identified for current or future planning, protection or acquisition."

AMSA designation and management plan approval is under the authority of the Coastal Policy Council. Any agency or member of the public could nominate the study area for AMSA designation. With concurrence of the CPC, a management plan would be prepared for state and private lands (including tidelands) within the AMSA. This plan would include a description of uses and activities allowable and prohibited within the AMSA, enforceable policies used to manage the AMSA, and a description of plan implementation.

Once approved by the CPC and the federal government, AMSA plan provisions are binding on state and federal agencies conducting activities or granting permits for activities within the AMSA. Proposed projects would be reviewed against AMSA plan policies during the consistency review process.

Option 4: Adoption of an Area Plan

DNR prepares and implements management plans, known as Area Plans, for state owned uplands, tidelands, and submerged lands. Area Plans do not apply to private lands and differ from AMSA plans in this respect. Area plans contain policies that apply to specific uses and activities, such as timber harvest, mining, recreation, or settlement. Planning areas are usually subdivided into management units, and lists of uses allowed or prohibited within each unit are developed. Area plans are reviewed by other agencies, the public, and approved by the Commissioner of DNR. Once an Area Plan is approved, all DNR decisions regarding land classifications, tideland leases, land use permits, and other authorizations must comply with the Area Plan requirements. Area Plan requirements are not binding on other agencies.

There are no Area Plans in effect within the study area. Information in this study would be useful if an Area Plan for the study area is prepared in the future.

Option 5: Classification of State Tidelands

State law requires state owned lands, including tidelands and submerged lands, be classified before they can be leased or sold. Land classification is a formal record of allowable uses for which each parcel of state land will be managed. Information in this study may serve as the basis for future DNR classification of state tidelands within the study area.

Option 6: Establish Regulatory Siting Guidelines

Reasonable regulation of any land use requires development and consistent use of siting criteria and guidelines. This study recommends a number of siting guidelines; additional ones may also be developed. Adoption of all or a portion of these guidelines through regulation is one way to ensure reasonable and consistent regulation of the aquatic farming industry.

Option 7: Tongass Land Management Plan Revision

The U.S. Forest Service is presently revising the Tongass Land Management Plan which in-

cludes Etolin Island. This revised plan will provide specific direction on how resources on Etolin Island will be managed. Recommendations in this study regarding the capability and suitability of shorelines of Etolin Island for mariculture development could be incorporated into the plan revision. When the Environmental Impact Statement for the plan is completed and the Record of Decision is signed, management direction for mariculture facilities on uplands under Forest Service jurisdiction should be consistent with recommendations made in this study. Until such time as the Revised Tongass Land Management Plan is completed, current Tongass Land Management Plan direction and guidelines will apply to mariculture developments.

RECOMMENDATIONS

Following are six general recommendations developed by state and federal agencies participating in the Etolin Island Area Mariculture Pilot Project. These recommendations target aspects of mariculture development indicated by this study to be of greatest concern. Revisions were made to these recommendations based on public comments made during this study.

Recommendation 1: Implementation of this Report

Siting guidelines and criteria developed in this study should be used by agencies in reviewing proposed projects, with recognition that flexibility is required to accommodate specific sites. Industry evolution should be considered in reviewing new or innovative techniques.

This study is not intended to be accepted or adopted as formal policy. The intent is to provide a comprehensive analysis of mariculture development within the study area for permitting agencies, prospective sea farmers and the interested public. This study represents one of the most comprehensive analysis of mariculture in Alaska to date.

Issues

Reasonable land use regulation must be based on **consistent** siting criteria and guidelines. During the development of an aquatic farm, measures to mitigate potential impacts can reduce potential social and environmental concerns. This study has proposed criteria and guidelines (see Chapter 3) describing mitigating measures on a case-by-case basis.

Mariculture is in a state of development. New and innovative techniques and technology may alter the culturing of sea organisms as we know it today. Flexibility will be necessary to properly evaluate and approve permits for proposed developments in the future.

Recommendation 2: Public Notification Process

Public notices for mariculture projects should be sent to all groups with potential information pertinent to that development. Individual public notices required by regulatory and land management agencies for mariculture development should be coordinated to the extent possible, so that notices are issued jointly or concurrently and coordinated with notice of the public hearing required by Chapter 145 SLA 88.

Issues

Current public notification processes may not reach all individuals or organizations likely to have information or comments about a proposed mariculture operation. A list of likely candidates for notification includes but is not limited to:

- Conservation Groups & Organizations
- State Parks Advisory Boards
- Commercial Fishing Organizations
- Fisheries Enhancement Group
- Organized Mariculture Development Groups

Recommendation 3: Compatibility With Other Uses

Mariculture development should be consistent with any approved federal, state or local government plans. All mariculture developments permitted by the State of Alaska adjacent to lands under management of other agencies should consider any land use designations by those adjacent land managers.

A task force should be formed to develop procedures for identification of significant use conflicts, policies to resolve conflicts during the district review process, and to develop review criteria to assign "best use" of public lands and waters.

Issues

A variety of uses occur on state tidelands either through natural phenomenon or by law. Mariculture sites should be developed: 1) where there is no significant conflict with existing or designated uses, 2) where conflict with natural fish and wildlife resources are minimal, or 3) where conflicts can be mitigated.

The State of Alaska manages lands adjacent to those managed or owned by the federal government, local communities and boroughs and private interests. The state manages a significant majority of all tidelands in Alaska. Mariculture development should be consistent with adjacent management designations and objectives to maintain integrity with the public and other land management agencies.

Recommendation 4 : Minimum Distance Between Sites

All issues affecting public safety and environmental protection should be thoroughly evaluated during agency review of proposed mariculture projects. Appropriate minimum distances should be established during this process.

At a minimum, public access shall be maintained. Effects on other farms should be considered as part of the permit review process.

Important considerations in permitting adjacent farms are:

1. Safe and viable navigational access.

2. Water quality degradation due to cumulative impacts.

3. Depletion of food resources of the cultured species.

4. Impacts on habitat.

During permit adjudication it will be the applicant's responsibility to demonstrate that proposed mariculture operations will not affect existing farm operations. Full consideration should be given at this time to demonstration of possible impacts on present mariculture operations from proposed developments.

Recommendation 5: Monitoring Farm Viability

Development Plans

A mariculture farm development plan is required for use of state tidelands authorized by a lease or permit from DNR. Elements of development plans are included in the Consolidated Shellfish Farm Application. These are: species to be raised; site plan and physical description; timetable for production and production goals. Information about the facility and its operation will also be taken from COE permits. Adherence to the development plan obtained through the application and COE permit should be monitored throughout the project's life to ensure continued operation viability. Adherence to development plans should be a condition of both permits and leases for mariculture developments.

Annual Report

A coordinated effort to develop annual reporting requirements should occur between the state resource agencies. The goal of this effort should be to require a single annual report which will serve to fulfill each agencies needs for information.
A detailed list of possible annual report requirements was generated through this study during the field test of the Consolidated Shellfish Farm Application evaluation located in Chapter 4.

A permit tracking and monitoring system should be developed based on information contained in the annual report required by the Shellfish Farm permit. The annual report will be used in part to determine and monitor commercial viability of mariculture developments. If under the proposed tracking and monitoring system a site is not developed as a

legitimate business venture or according to an approved development plan, the permits would be revoked.

Information requested from sea farmers in the annual report should be clearly identified as pertinent to area management. Moderate amounts of information should be requested and should be reasonably obtainable by sea farmers.

Issues

Use of public resources authorized by the state should be developed by applicants in a manner consistent with good business and development practices. It is in the state's best interest to ensure responsible development of state lands and resources balanced with resource protection.

Mariculture operations on public lands should be required to maintain a level of enterprise that has been identified in development plans. Mariculture farms operating at levels far below their plan proposals should not be allowed to occupy public lands at the risk of possible displacement of other uses of state land.

1. Mariculture sites with good potential that are permitted but not developed for many years preclude more aggressive developers from a legitimate opportunity.

2. Good sites may be tied up by individuals whose goal is to have a cabin at a remote site and a subsistence lifestyle, enjoy recreation opportunities, obtain desirable access to commercial fishing or secure interests for purposes other than mariculture development. These individuals may install minimal facilities with small numbers of organisms and in fact market minimal product quantities. Public resources should be permitted or leased to legitimate developers, not subsistence or recreation users.

3. Speculation is a concern among resource agencies. An individual or organization may apply for appropriate permits with the intent of acquiring a site to obtain land rights that may be sold or traded at a later date.

Part time farmers can and do contribute to overall development of mariculture in Alaska. Part time farmers can postpone high initial capital costs by beginning with modest investments and adding to facilities as expertise and capital are acquired. This approach is acceptable and can continue if progressive development with the goal of independent, economically viable enterprise is demonstrated by the sea farmer. This recommendation is not intended to preclude small or part time sea farmers.

Recommendation 6: Future Studies

The scope and time frame of this project does not allow for a detailed evaluation of several issues related to Alaska mariculture viability. The following recommendations are proposed for future studies and investigations to obtain more detailed information on specific mariculture issues in Alaska.

1. A PSP data base should be developed. Sources of information include annual shellfish farm permit reports, and results of PSP testing done by DEC and other state and federal agencies.

2. Site capability parameters for sea organisms grown in Alaska should be studied by the state, and/or universities and results made available to permitting agencies and the public.

3. Flushing capabilities of potential mariculture sites are central to many aspects of mariculture development. An inventory of situations that may develop anaerobic conditions would be very helpful to technical agencies and prospective sea farmers alike.

4. Funds should be made available for work on a regular basis to integrate information generated from studies already underway or planned for the future. Specifically included here are the current Marine Advisory Program's Remote Sensing Project and the results of the present Southeast Alaska subsistence study.

5. A study similar to the Etolin Island Area Mariculture Pilot Project should be conducted for other forms of sea culture if they are authorized by the Alaska legislature.

SUMMARY OF PUBLIC COMMENT

The Public Review Draft of the Etolin Island Area Mariculture Pilot Project was available for public examination and comment for a 30 day period in June. Comments were accepted at public workshops held in Wrangell and Petersburg and by mail and telephone. Several comments and observations were received.

Since the project will not be adopted as a plan, or be implemented as policy, comments effected the project in two ways:

1. Several areas of the project received additional detail to clarify issues. Inaccuracies were corrected.

2. Comments were made available to cooperating agencies. Major issues and concerns were brought to the attention of resource managers involved in mariculture development.

The following is a summary of comments received during the Public Review Draft comment period with a summary of current policy, clarification of issues and proposals effecting the comment if applicable:

Comment 1: Some oyster growers would like to see state assistance in developing an Alaska oyster spat hatchery. Some growers believe the state should design, develop, build and support a hatchery in Alaska to provide spat to Alaska oyster growers.

Response: Currently, no oyster spat is produced in Alaska. Oyster spat is available from three hatcheries, located in Washington, California and British Columbia. Although at least one of the hatcheries report efforts to enlarge spat production, Alaska oyster growers report shortages and inability to secure all spat needed for farm maintenance and growth.

The State of Alaska has no plans for development of an oyster spat hatchery.

Comment 2: An "Alaska strain" of oyster spat should be developed. Some growers believe a strain of oysters could be developed that would grow better in conditions commonly found in Alaska.

Response: No effort is currently underway, and none is planned to create an "Alaska strain" of oysters. There are some question, among agencies responsible for monitoring oyster spat sources, if such development would be desirable environmentally or biologically.

Until these questions are answered, it is unlikely an "Alaska strain" will be developed or authorized for growing in Alaska.

Comment 3: Farm development plans are not practical because no secure and reliable source of spat exists for oyster growers. Therefore,it is not possible to predict how many oysters could be sold on a yearly basis making a development plan difficult if not impossible.

Response: A separate detailed development plan is not proposed for aquatic farmers at this time. However, information required on the Consolidated Shellfish Farm Application provides information that constitutes a "development plan". Accomplishing proposed yearly production goals is only one element of farm viability. Other elements include the following:

1. A site plan drawn to scale (no less than 1"-50' which shows the layout and location of the following:

   a. The rafts or other production facilities employed (size and number).

   b. Anchoring systems and shore ties.

   c. Docks, floathomes, or caretaker facilities including: sources of freshwater

for domestic use and for processing, waste water disposal systems, and solid waste storage and disposal.

d. Any freshwater discharges.

e. Roads or airstrips.

f. Other upland or tideland facilities at the site associated with the farming operation.

g. Fuel and chemical storage.

h. properties of adjacent upland and tideland owners (location).

2. Species to be raised and annual production goals.

3. Description and location of proposed sewage systems.

4. Timetable of approximate dates for: installation of spat collection gear, placement of production facilities, date of first sale, schedule for reaching maximum production.

Inability to obtain spat could easily prevent a farmer from reaching proposed productions goals, as could mass natural mortality and a number of other circumstances. Permitting agencies acknowledge the potential of "crop" failures common to growing food crops. However, a farmer continually unable to procure spat while neighboring farms are successful may be required to provide additional information on development efforts and intentions of the farm.

Failure to obtain necessary permits and authorizations, lack of progress on installation of facilities, lack of efforts to secure spat, development of facilities grossly inconsistent with site plans, or failure to develop farms consistent with resource protection could cause permit review and farm evaluation. If the situation warrants, the permit may be revoked and the area made available for a more aggressive farmer.

Comment 4: There needs to be a PSP laboratory located closer to oyster growing areas.

Response: Currently, the state maintains and operates a PSP testing laboratory in Palmer Alaska. It is the only one available to oyster growers, and its services are provided free of charge to the sea farmer. The farmer must pay for shipping costs of samples to the lab however.

There is interest from private laboratories located in Ketchikan in obtaining PSP testing certification.

The state has no plans for any additional state operated PSP testing facilities in Alaska.

Comment 5: A tideland classification needs to be adopted for mariculture.

Response: Classifications result from state planning and regulatory processes. Tideland classifications could be implemented through changes in existing regulations.

Comment 6: A data base needs to be created for PSP and pathogens in oyster growing areas in Alaska.

Response: The annual report required for Shellfish Farm Permit holders should provide some information on farm environment conditions. No other systematic collection and analysis of data is planned at this time.

Comment 7: A graduated scale for permit and lease fees needs to be adopted that would charge higher fees for land use when larger amounts of products are being produced.

Response: Current policy is to charge a fixed amount with no graduated scale for permits. Lease fees are established at fair market value.

Comment 8: Some information presented is too technical and not very comprehensible to the nonscientific public.

Response: The final report reflects much clarification of issues due to comments during the review period. Efforts were made throughout the document to clarify technical "jargon" and information. However, much of these sections retain their technical nature due to subject matter.

Comment 9: Areas known for high recreation of fish and wildlife harvest should be prohibited, not simply discouraged. Decisions to reject a proposal should not be dependent upon having "feasible and prudent alternatives". Existing uses may have a very high value to area residents and should be respected and protected by state agencies.

Response: Comments referred to permitting agencies for consideration.

Comment 10: We are glad to see that there will be periodic assessment of the cumulative impacts in areas of high potential development. However, what is meant by periodic?

Response: Aquatic farms will initially be monitored yearly through the annual report. Agencies have yet to develop policy on a comprehensive evaluation program.

Comment 11: How will conflicts be resolved?

Response: Conflicts are resolved during permit processing and adjudication process.

Comment 12: A method should be developed to determine when too much of the natural balance is at risk.

Response: Referred to permitting agencies for consideration.

Comment 13: Would the public have an opportunity to comment on the acceptability of the controversial techniques if they were proposed for Alaska?

Response: Public comment periods are mandated for proposed mariculture development in recently enacted legislation. Public comments can be made through a variety of channels including Fish and Game Boards, advisory councils and through the Departments directly on management actions not covered through the permit review processes.

Comment 14: Is public notice required for permits since permit holders are given prior right to that lease?

Response: Public notice for permits and leases is required.

Comment 15: We feel areas adjacent to LUD I Release Areas should remain in undisturbed condition and that no new permits should be issued in the future.

Response: This study recommends management goals of properties adjacent to proposed mariculture facilities should be evaluated during the adjudication process and permit decisions made accordingly.

Comment 16: We agree that "lack of regional perspective could lead to significant conflicts over time". Is there anything that can be done to alleviate this problem?

Response: Recent legislation has given considerable guidance on the development of mariculture in Alaska. Continued development of policy and regulations should address the regional perspective issue. Referred to permitting agencies for consideration.

Comment 17: A social impact study should be done in the future.

Response: Referred to cooperating agencies for consideration.

In addition to the above listed comments, several requests for clarification of issues were received. Some of these issues included: intensive use, significant conflicts, and ADF&G numbered streams. Additional requests were for clarification of other studies cited in the report.

Etolin Island Area

Mariculture Pilot Project

APPENDIXES

Appendix A

UNIVERSITY OF ALASKA - MARINE ADVISORY PROGRAM

Project Title: Feasibility of Using Remote Sensing to Identify the Aquataculture Potential of Coastal Waters

Project Summary

(1) Key words; remote sensing, aquaculture, estuaries, oysters

(2) Objectives:

(A) To test the feasibility of using conventional, free access aerial and satellite sensors to collect selected oceanographic data from estuaries and adjacent waters. In addition, to test the feasibility of the routine analysis of complex environmental data by state resource managers.

(B) Using standard bathymetric or navigational charts as base maps, to make use of a conventional chart overlay system; to identify areas appropriate for the commercial suspended cultivation of Pacific oysters (Crassostrea gigas). This study will be limited to factors considered essential for the cultivation of oysters. Each variable (such as mixed layer temperature) will be charted on a Mylar overlay sheet superimposed on the master chart of the estuary under study.

(C) To establish a set of physical and biological criteria determined to be essential to the successful cultivation of oysters using standard suspended techniques (i.e. tray and longline culture). It is anticipated that project results can also be applied to the selection of culture sites for other species with environmental requirements occupying relatively narrow ranges.

(D) Major objective of this study is to compare the environmental requirement of oysters with the analyzed data charts. The expected outcome will be the delineation of estuarine areas with a significant potential for oyster culture.

(E) This project is restricted to a study site in central Southeast Alaska. The long term objective of the project is to make a contribution to the development of a simple, possible automated, environmental assessment procedure that can be applied to the needs of resource managers.

(F) To establish a set of catalogs, inventorying a set of significant environmental variables to be considered either individually or in combination to predict the probable success of oyster culture.

(G) To suggest methods by which the procedure can be used locate areas capable of supporting other types of aquaculture.

(H) By the identification of prime culture areas, it is hoped that this project will allow for the protection of potential oyster culture areas and efficient use of coastal resources.

(I) To assist other states and provinces in the implementation of similar environmental mapping and cataloging procedures.

(3) Methodology

A) Obtain and refine base map for primary and alternate study sites. These two areas have existing commercial oyster cultures operations. It is believed that both areas possess many additional culture sites.

(B) Formulate set of environmental criteria customarily used to select suspended culture sites (reviews of literature and field practice). Each criterion will be stated in form of permissible range and as an optimum value (latitudinal corrections to be made). Selection criteria are as follow:

(a) temperature of mixed layer (degrees C\0)

(b) surface current velocity (cm/sec)

(c) salinity (parts per thousand)

(d) plankton count to be interpreted in form of chlorophyll a (ug/l)

(e) turbidity (NTU - with extreme bias favoring sites lacking turbidity)

Note: not included in this list are two major qualifying criteria (depth and wave energy)

(C) Study to concentrate on conditions during four seasonal periods:

(a) late winter (temperature minimum)

(b) mid spring and late fall (periods of salinity minimum)

(c) late summer (temperature maximum)

(D) Each of the above environmental criteria will be linked to a specific aerial or satellite sensor(s). Particular to sensor to be used will be based on ease of public access to data, relative accuracy of data, frequency of data, cost, and ease of interpretation. Archived as well as actual data to be considered.

(E) As stated in item (C) above, data collection to be most intensive during four seasonal "windows (each approximately fourteen days long). Multiple data sets will be acquired within each seasonal window in order to determine "average" values (may be necessary to place heavy reliance on archived data for several variables). Accuracy of all remotely sensed data to be verified via "ground truth " data consisting of direct oceanographic measurements.

(F) Environmental data for each of the five criteria will be mapped and analyzed using computerized "geographic information system" (GIS) technology. Standard procedures will be used. A subcontractor (Recon Research, Bend Oregon) has agreed to perform certain aspects of this work.

(G) This project faces several major challenges. Two anticipated problems to be overcome are gaining access to some data and resolution difficulties. The major challenge will be to develop strategies to interpret the seasonal behavior of salinity which currently is not possible to measure via remote sensing techniques available to non-military researchers.

(H) Oyster culture requirements (in the form of five environmental criteria) will be compared to the mapped data. General areas and,hopefully, prime microenvironments, capable of supporting suspended oyster culture will be mapped. Determining the feasibility of creating single purpose estuary resource maps of this sort (oyster culture, scallop culture, salmon farming, etc.) is the major objective of this project.

(I) The system developed by this project will be graded on its accuracy, practical operation, cost and applicability to other species (assumes focus on aquaculture, although other economic activities may also benefit). The evaluation will determine whether this procedure is appropriate for routine large-scale examinations of the natural world.

Not examined in this study is the potential of computerization and automation of data collection, analysis, and mapping functions.

(J) Resource maps will be circulated among estuary users prospective oyster farmers, water resource managers, and policy makers. The decision to implement the system and proceed with large scale environmental cataloging will be the responsibility of regional managers.

(4) Expected Results

(A) This project provides for mapping of several types of environmental data using standard techniques. However, this project is unique in that it attempts to interpret massive data sets gained by satellite during four seasonal periods. This project will begin the development of an automated or semi-automated system capable of the rapid integration of mapped environmental information, the comparison of this information to the known growth requirement of cultured organisms, and the delineation of estuarine regions capable of supporting specific aquaculture activity.

(B) It is expected that this method of environmental assessment will have reasonable accuracy, be relatively inexpensive, and will become an important tool in the initial identification of potential aquaculture sites.

(C) Preliminary and final project results will be transmitted to regional resource managers and members of the developing aquaculture industry by means of a Pacific Sea Grant technical publication.

(5) Summary of Rationale:

(A) The establishment of bivalve aquaculture requires careful consideration of oceanographic conditions.

(B) Traditional methods of oceanographic examination though of unquestioned accuracy, are costly, time consuming and unable to cope with the rapid examination of multiple environmental variables.

(C) Various states and provinces, with the rise of various water resource user groups (tourism, expanded urbanization, aquaculture, etc.) are faced with the increased need to catalog the environmental characteristics of coastal regions.

(D) It is unlikely that most states will have available the necessary technical and financial resources needed to develop comprehensive estuarine resource inventories using traditional direct sampling procedures. Pacific states and the Province of British Columbia are now facing steady pressure from a variety of prospective coastal resource users.

(E) Use of remote sensing may provide a means of acquiring and cataloging environmental information which, though of significantly lower accuracy than directly sampled data, can be used in the effective planning of coastal development.

(F) Moreover, it is expected that the practical application of remote sensing will be both timely and inexpensive.

(G) This project will test the utility of currently available sensors. It is quite possible that weaknesses uncovered during this project will be resolved through the advent of a new generation of more sophisticated environmental sensors.

Appendix B

AGENCY AUTHORITIES IN THE STUDY AREA

State Authorities

Alaska Department of Fish and Game

16 US 661 et seq.	Fish & Wildlife Coordination Act
AS 16.40.100-199	Aquatic Farm and Hatchery Permit; Aquatic Stock Acquistion Permits
AS 16.05.251	Regulations of the Board of Fisheries
AS 16.05.840	Fishway Act
AS 16.05.870	Anadromous Fish Act
5 AAC 40.	Permits for Private non Profit Hatcheries
5 AAC 41.	Transportation, Possession and Release of Live Fish
5 AAC 41.	Shellfish Farm Permit
5 AAC 95.	Protection of Fish & Game Hatcheries
6 AAC 50	Project Consistency Review Process
6 AAC 80	ACMP Standards

Alaska Department of Environmental Conservation

Sec. 401	Federal Clean Water Act
Title 33 CFR	Federal Dredge and Fill Regulations
AS 03.05.020	Powers of the Commissioner of DEC
AS 03.05.025	Seafood Processing Permits and Plans of Operation
AS 03.05.035	Sale and Labeling of Frozen Meat, Fish, and Poultry
AS 03.05.040	Inspection
AS 03.05.050	Products in Violation of Regulations
AS 03.05.090	Penalty for Violations
AS 17.20.230	Detention or Embargo of Goods
AS 17.20.250	Destruction of Adulterated or Misbranded Goods.
AS 46.03.020	Powers of the Department
AS 46.03.060	Plan Review for Sewage Disposal
AS 46.03.090	Plan for Pollution Disposal
AS 46.03.100	Waste Disposal Permit
AS 46.03.110	Waste Disposal Permit Procedure
AS 46.30.140	Air Quality
AS 46.07.020	Monitor Public Water Systems
AS 46.03.060	Broad Water Quality Enforcement
6 AAC 50.	Project Consistency Review Process
6 AAC 80.	ACMP Standards
18 AAC 34.	Fish Inspection Regulations
18 AAC 60.	Solid Waste Management
18 AAC 62.	Hazardous Waste

18 AAC 70.	Water Quality Standards
18 AAC 72.	Wastewater Disposal
18 AAC 80.	Drinking Water

Alaska Coastal Management Program

AS 44.19.155.	Alaska Coastal Policy Council
AS 46.40.	Alaska Coastal Management Act
6 AAC 50.	Project Consistency Review Process
6 AAC 80.	ACMP Standards

Department of Commerce and Economic Development

No Authorities

DNR - Division of Forestry

AS 41.17.010	Forest Resources and Practices
AS 45.50.235	Log Salvage
AS 38.05.110	Sale of Timber & Materials
AS 38.05.115	Sale Limitations
6 AAC 50.	Project Consistency Review Process
6 AAC 80.	ACMP Standards
11 AAC 71.400	Log Salvage
11 AAC 95.	Forest Resources and Practices

DNR - Division of Mining

AS 38.05.185	Mining Rights
AS 38.05.250	Offshore Prospecting Permits
6 AAC 50.	Project Consistency Review Process

6 AAC 80	ACMP Standards
11 AAC 86.500	Offshore Prospecting Permits
11 AAC 86.135	Mineral Deposits Open to Location

DNR - Division of Land and Water Management

AS 38.04.005	Public and Private Land Use
AS 38.04.010	Public Land for Private Use
AS 38.04.015	Public Retention of Lands
AS 38.04.020	Land Disposal Bank
AS 38.04.021	Municipal Entitlement
AS 38.04.065	Land Planning
AS 38.04.070	Management Categories
AS 38.04.050	Land Disposals
AS 38.04.070	Leasing of State Lands
AS 38.04.082	Shore Fisheries
AS 38.05.127	Access to Public Waters
AS 38.05.290	Land Selections
AS 46.15.030	Appropriation of Water
AS 46.15.050	Instream Flow
AS 46.15.145	Federal Reserve Water Rights
11 AAC 54	Disposal of Lands
11 AAC 55	Planning and Classification
11 AAC 58	Leasing of Lands
11 AAC 62	Tide and Submerged Lands
11 AAC 64	Shore Fisheries Leasing
11 AAC 66	Municipal Entitlement
11 AAC 67	Disposal of Land

11 AAC 71	Timber and Material Sales
11 AAC 86	Mining Rights
11 AAC 93	Water Management
6 AAC 50	Project Consistency Review Process
6 AAC 80	ACMP Standards

Federal Authorities

U.S. Forest Service

The Creative Act (1891)

The Organic Act (1897)

The Weeks Law Act (1911)

The Multiple Use-Sustained Yield Act (1960)

The Wilderness Act (1964)

The Land and Water Conservation Fund Act (1964)

The National Environmental Policy Act (1969)

The Coastal Zone Management Act (1972)

The Endangered Species Act (1973)

The Forest and Rangelands Renewable Resources Act(1974)

The Sikes Act (1974)

The National Forest Management Act (1976)

The Federal Land Policy and Management Act (1976)

Alaska National Interest Lands Conservation Act (1980)

U.S. Army Corps of Engineers

Rivers and Harbors Act (1899) (Section 10)

Clean Waters Act (33 U.S.C. 1344, Section 404)

The Coastal Zone Management Act (1972)

U.S. Fish and Wildlife Service

16 U.S.C. 668	Bald Eagle Act 1940
16 U.S.C. 742(a)	Fish and Wildlife Act 1956
16 U.S.C. 757(a)	Anadromous Fish Conservation Act
16 U.S.C. 703	Migratory Bird Treaty Act of 1918
16 U.S.C. 1361-1362	Marine Mammal Protection Act of 1972
16 U.S.C. 1371-1384	Fish and Wildlife Coordination Act
16 U.S.C. 1451	Coastal Zone Management Act of 1972
16 U.S.C. 1221-1226	Estuary Protection Act
42 U.S.C. 4321	National Environmental Policy Act

National Marine Fisheries Service

16 U.S.C. 1361, 1362	Marine Mammal Protection Act of 1972
16 U.S.C. 1451	Coastal Zone Management Act of 1972
16 U.S.C. 1371-1384	Fish and Wildlife Coordination Act
42 U.S.C. 4321	National Environmental Policy Act

Appendix C

1988 Coastal Project Questionnaire

STATE OF ALASKA
OFFICE OF THE GOVERNOR

STEVE COWPER, GOVERNOR

CENTRAL OFFICE
P.O. BOX AW
JUNEAU, ALASKA 99811-0165
PHONE: (907) 465-3562

OFFICE OF MANAGEMENT AND BUDGET
DIVISION OF GOVERNMENTAL COORDINATION

SOUTHEAST REGIONAL OFFICE
431 NORTH FRANKLIN
P.O. BOX AW, SUITE 101
JUNEAU, ALASKA 99811-0165
PHONE: (907) 465-3562

SOUTHCENTRAL REGIONAL OFFICE
2600 DENALI STREET
SUITE 700
ANCHORAGE, ALASKA 99503-2798
PHONE: (907) 274-1581

NORTHERN REGIONAL OFFICE
675 SEVENTH AVENUE
STATION H
FAIRBANKS, ALASKA 99701-4596
PHONE: (907) 451-2818

1988 COASTAL PROJECT QUESTIONNAIRE

Dear Applicant:

The State of Alaska has a system for reviewing and processing all the resource-related permits, leases, and approvals which are required for proposed projects in coastal areas of Alaska. The project consistency review process is based on the Alaska Coastal Management Program and is designed to improve management of Alaska's coastal land and water uses. Project proposals are reviewed to:

- Determine the project's consistency with the Alaska Coastal Management Program.
- Identify permits required by the state resource agencies, that is, the Alaska Departments of Environmental Conservation, Fish and Game, and Natural Resources.
- Trigger the issuance of necessary permits and other authorizations by state resource agencies.

If a federal permit or permits from more than one state agency are required, the consistency review process is coordinated by a regional office of the Division of Governmental Coordination (DGC). If permits from only one state agency are required, the state agency responsible for issuing those permits coordinates the review. Your answers to this questionnaire will determine who is the appropriate coordinating agency. Contact the nearest DGC regional office for more information.

Before you settle on your final project plans and submit your application, the state can arrange for meetings between you and state agency representatives to review your completed coastal project questionnaire. Preapplication meetings can help identify concerns and information needs, and encourage a mutual understanding of your project. To arrange for a preapplication meeting, call or write the coordinating agency contact.

To begin the review process you must complete the attached Coastal Project Questionnaire to determine which permits are needed. The consistency review begins upon receipt of your complete application packet. A complete packet includes:

- A signed Coastal Project Questionnaire.
- Copies of any state permit applications needed for the project (originals go to the state agency issuing the permit).
- Copies of any federal permit applications needed for the project (originals go to the federal agency issuing the permit).
- Any additional pertinent information including public notices from agencies.

YOUR PROJECT CANNOT BE REVIEWED UNTIL A COMPLETE PACKET INCLUDING ALL APPLICATIONS IS RECEIVED. You must submit the completed packet to the appropriate state agency in the region where the proposed project is to occur. Attached is a list of regional agency contacts and a map of the coastal area with the regions delineated. All packets must be submitted to the Division of Governmental Coordination (DGC), with the following exceptions:

1. If a fee is required, submit the original application, coastal project questionnaire, and fee to the state resource agency with the fee requirement (include a copy of that permit application in the packet to DGC).
2. If a state permit application requires confidential information, submit the entire packet to the state resource agency with that requirement.
3. If the project is a placer mining activity, submit the Annual Placer Mining Application, instead of the questionnaire, to the Department of Natural Resources, Division of Mining.
4. If you need permits from only one state resource agency and no federal agencies, submit the entire packet to the state resource agency requiring the permits.

If one or more federal permits are required, submit the original federal permit application(s) to the federal agency and send a copy of those federal applications to the appropriate state agency along with your packet of other applications.

STEPS IN THE REVIEW PROCESS

Start-up: You will be notified when the review starts. You will receive your project's assigned review number, review schedule, and other information. Participants in the review process include:

1. You, the applicant;
2. State resource agencies and the Division of Governmental Coordination;
3. The affected local coastal community; and
4. Other interested members of the public.

Information requests: Agencies may request additional information from you during the review. The coordinating agency may stop the review until that information is received.

Proposed determination: After reviewing comments on your project, the coordinating agency will develop a proposed consistency determination which will be presented to you, state resource agencies, and coastal districts.

Conclusive determination: A conclusive consistency determination will be issued upon agreement of the proposed determination by you, state resource agencies, and coastal district with an approved program.

Elevation (appeal) process: If you do not concur with the proposed determination for your project, you may request elevation, or further review by division directors within the state resource agencies. The directors review the proposed determination and any additional information included in the elevation request, then issue a second proposed determination.

You may then elevate the review to the commissioners of the resource agencies if the director-level review does not satisfy your interests. This is the final step in the administrative appeal process. Each elevation review can take no longer than 15 days. State resource agencies and coastal districts with approved programs may also request elevation.

In addition to the state's elevation process, if your project requires a federal permit and you disagree with the state's final conclusive consistency determination, you may appeal to the U.S. Secretary of Commerce in Washington, D.C., as provided in 15 CFR 930.125(H).

Permits: Agencies will issue state permits covered by the determination within five days after the conclusive consistency determination is issued unless that agency finds that additional review is necessary to fulfill other statutory requirements. The agency will notify you if their permits will not be issued.

Review Schedules

The coordinating agency must complete the review of your project within 30 or 50 days. A 30-day review schedule will be used if all associated state permits must by statute or regulation be issued in 30 days. A 50-day review schedule will be used for projects with approvals requiring a 30-day public notice. The coordinating agency may grant extensions to these schedules as provided under 6 AAC 50.110. For example, if your project is located in the unorganized borough, the comment and decision deadlines may be extended for 10 days. The deadlines may also be extended at the request of the applicant, or to receive additional information requested by a resource agency.

	30-Day Review	50-Day Review
Consistency review begins	Day 1	Day 1
Deadline for regional reviewers to request additional information	Day 15	Day 25
Public and agency reviewer comments due	Day 17	Day 34
Notification for elevation	Day 29	Day 49
Conclusive consistency determination issued (unless elevation requested)	Day 30	Day 50
If elevated, director's determination	Day 45	Day 65
If elevated again, commissioner's determination	Day 60	Day 80

Coastal Project Questionnaire and Certification Statement

Please answer all questions. Include maps or plan drawings with your packet. An incomplete questionnaire may be returned and will delay the review of your packet.

APPLICANT INFORMATION

1. _____
Name of Applicant

_____
Address

_____
City State Zip Code

_____
Phone

2. _____
Contact Person

_____
Address

_____
City State Zip Code

_____
Phone

PROJECT INFORMATION

1. Provide a brief description of your project and ALL associated facilities (caretaker facilities, etc.):

_____

_____

Starting Date for Project _____ Ending Date for Project _____

PROJECT LOCATION

1. Please give location of project. (Include nearest community or identifiable body of land or water.)

_____

Township _____ Range _____ Meridian _____ Section _____ Aliquot Parts _____ USGS Map _____

2. Is the project on: *(please mark with ✓)*

State Land _____ Federal Land _____ Private Land _____ Municipal Land _____

3. Project is located in which region of the state (see attached map):

Northern _____ Southcentral _____ Southeast _____

PERMIT APPROVALS

1. Do you currently have any State or federal approvals for this project? If yes, please list below. (Note: *approval* means permit or any other form of authorization.) Yes ☐ No ☐

Approval Type	Approval #	Expiration Date

FEDERAL APPROVALS

1. Will you be placing structures or fills in any of the following: tidal waters, streams, lakes, or wetlands*? Yes ☐ No ☐

** If you are uncertain whether your proposed project area is in a wetland, contact the Corps of Engineers, Regulatory Branch at (907) 753-2720 for a wetlands determination. If you are outside the Anchorage area, call toll free 1-800-478-2712.*

If yes, have you applied for or do you intend to apply for a U.S. Army Corps of Engineers (COE) permit? Please indicate at right and describe below. Yes ☐ No ☐

2. Have you applied for or do you intend to apply for a U.S. Environmental Protection Agency National Pollution Discharge Elimination System (NPDES) permit? Please indicate at right and describe below. (Note: Any wastewater discharge requires an NPDES permit.) Yes ☐ No ☐

3. Have you applied for or do you intend to apply for permits from any other federal agency? If yes, please list below. Yes ☐ No ☐

Agency	Approval Type	Date submitted (or intend to submit)

DEPARTMENT OF NATURAL RESOURCES APPROVALS

1. Is the proposed project on state-owned land or will you need to cross State lands for access? Yes ☐ No ☐

2. Is any portion of your project placed below the ordinary high water line of a stream, river, lake or other water body? Yes ☐ No ☐

3. Will you be dredging? If yes, location of dredging is: Yes ☐ No ☐

   Township _____ Range _____ Meridian _____ Section _____

   • Location of disposal site for dredged materials:

   Township _____ Range _____ Meridian _____ Section _____

4. Will you be filling with rock, sand or gravel? If yes, amount? _____ Yes ☐ No ☐

   • Location of source: Township _____ Range _____ Meridian _____ Section _____

   • Location of area to be filled: Township _____ Range _____ Meridian _____ Section _____

5. Do you plan to use any of the following state-owned resources? Yes ☐ No ☐

   Timber

   • If yes, amount? _____

   • Location of source: Township _____ Range _____ Meridian _____ Section _____

   Other Materials

   • If yes, what material? _____
   (peat, building stone, silt, overburden, etc.)

   • Location of source: Township _____ Range _____ Meridian _____ Section _____

6. Are you planning to use any fresh water? Yes ☐ No ☐

   • If yes, amount (gallons per day)? _____

   • Source? _____

7. Will you be building or altering a dam? Yes ☐ No ☐

8. Do you plan to drill a geothermal well? ☐ ☐

9. Will you be exploring for or extracting coal? ☐ ☐

10. Will you be exploring for or extracting minerals on state-owned land? ☐ ☐

11. Will you be exploring for or extracting oil and gas on state-owned land? ☐ ☐

12. Will you be harvesting timber from 10 or more acres? ☐ ☐

13. Will you be investigating or removing historical or archaeological resources on state-owned land? Yes ☐ No ☐

14. Will the project be located in a unit of the Alaska State Park System? Yes ☐ No ☐

If you answered NO to all questions in this section, you do not need an approval from the Alaska Department of Natural Resources (DNR). Continue to the next section.

If you answered YES to ANY questions in this section, contact DNR to identify and obtain necessary application forms.

Based on your discussion with DNR, please list (below) the approval type needed and date submitted.

Approval Type	Date Submitted (or intend to submit)

Have you paid the filing fees required for the DNR permits? Yes ☐ No ☐

If you are not applying for DNR permits, indicate reason below:

____ a. _____ (DNR contact) told me on _____(date) that no DNR approvals or permits were required on this project.

____ b. Other: _____

DEPARTMENT OF FISH AND GAME APPROVALS

1. Will you be working in a stream, river, or lake? (This includes running water or on ice, within the acive floodplain, on islands, the face of the banks, or the stream tideflats down to mean low tide.) Yes ☐ No ☐

   Name of stream or river:_____ Name of lake:_____

   If you answered "no", proceed to question #2.

   If "yes", will you be doing any of the following:

	Yes	No
a) Building a dam, river training structure or instream impoundment?	☐	☐
b) Using the water?	☐	☐
c) Diverting or altering the natural channel stream?	☐	☐
d) Blocking or damming the stream, (temporarily or permanently)?	☐	☐
e) Changing the flow of the water or changing the bed?	☐	☐
f) Pumping water out of the stream or lake?	☐	☐
g) Introducing silt, gravel, rock, petroleum products, debris, chemicals or wastes of any type into the water?	☐	☐
h) Using the stream as a road (even when frozen), or crossing the stream with tracked or wheeled vehicles, log-dragging or excavation equipment (backhoes, bulldozers, etc.)?	☐	☐
i) Altering or stabilizing the banks?	☐	☐
j) Mining or digging in the beds or banks?	☐	☐
k) Using explosives?	☐	☐
l) Building a bridge (including an ice bridge)?	☐	☐
m) Installing a culvert or other drainage structure?	☐	☐
n) Constructing a weir?	☐	☐

	Yes	No
o) Other in-stream structure not mentioned above?	☐	☐
2. Is your project located in a State Game Refuge, Critical Habitat Area, or State Game Sanctuary?	☐	☐
3. Does your project include the construction and operation of a salmon hatchery?	☐	☐
4. Does your project affect or is it related to a previously permitted salmon hatchery?	☐	☐
5. Does your project include the construction of a shellfish or sea vegetable farm?	☐	☐

If you answered NO to all questions in this section, you do not need an approval from the Alaska Department of Fish and Game (DFG). Continue to the next section.

If you answered YES to any of the questions under 1 or 2, contact the Regional DFG Habitat Division Office for information and application forms.

If you answered YES to questions 3, 4 or 5, contact the DFG Private Nonprofit Hatchery Office at the F.R.E.D. division headquarters for information and application forms.

Based on your discussion with DFG, please list (below) the approval type needed and date submitted. Yes ☐ No ☐

Approval Type	Date Submitted (or intend to submit)

If you are not applying for permits, indicate reason below:

____ a. _____ (DFG contact) told me on _____(date) that no DFG approvals or permits were required on this project.

____ b. Other: _____

DEPARTMENT OF ENVIRONMENTAL CONSERVATION APPROVALS

	Yes	No
1. Will a discharge of wastewater from industrial or commercial operations occur? (See #2 in "Federal Permits" section)	☐	☐
2. Will your project generate air emissions from the following:	☐	☐
a) Diesel generators totaling more than 10,000 hp?	☐	☐
b) Other fossil fuel-fired electric generator, furnace, or boiler totaling greater than 10,000 hp, or 9,000 kWh, or 100,000,000 btu/hr?	☐	☐
c) Asphalt plant?	☐	☐
d) Incinerator burning more than 1000 lbs. per hour?	☐	☐
e) Industrial process?	☐	☐
3. Will a drinking water supply be developed that serves more than a single-family residence?	☐	☐
4. Will you be processing seafood?	☐	☐
5. Will food service be provided to the public or workers?	☐	☐
6. Will the project result in dredging or disposal of fill in wetlands or placement of a structure in waterways? (Note: your application for this activity to the Corps of Engineers will also serve as your application to DEC.)	☐	☐
7. Is sewage or greywater disposal involved or necessary?	☐	☐

8. Will your project result in the development of a currently unpermitted facility for the disposal of domestic or industrial solid waste? ☐ ☐

9. Will your project require offshore drilling or vessel transport of oil, or other petroleum products as cargo, or include onshore facilities with an effective storage capacity of greater than 10,000 barrels of such products? ☐ ☐

10. Will your project require the application of oil or pesticides to the surface of the land? ☐ ☐

If you answered NO to all questions in this section, you do not need a permit or approval from the Alaska Department of Environmental Conservation (DEC). Please continue to the next section.

If you answered YES to any of these questions (see #6 Note), contact the DEC Regional Office for information and application forms.

Based on your discussion with DEC, please list (below) the approval type needed and date submitted.

Approval Type	Date Submitted (or intend to submit)
_____	_____
_____	_____
_____	_____

If you are not applying for permits, indicate reason below:

____ a. _____ (DEC contact) told me on _____(date) that no DEC approvals or permits were required on this project.

____ b. Other: _____

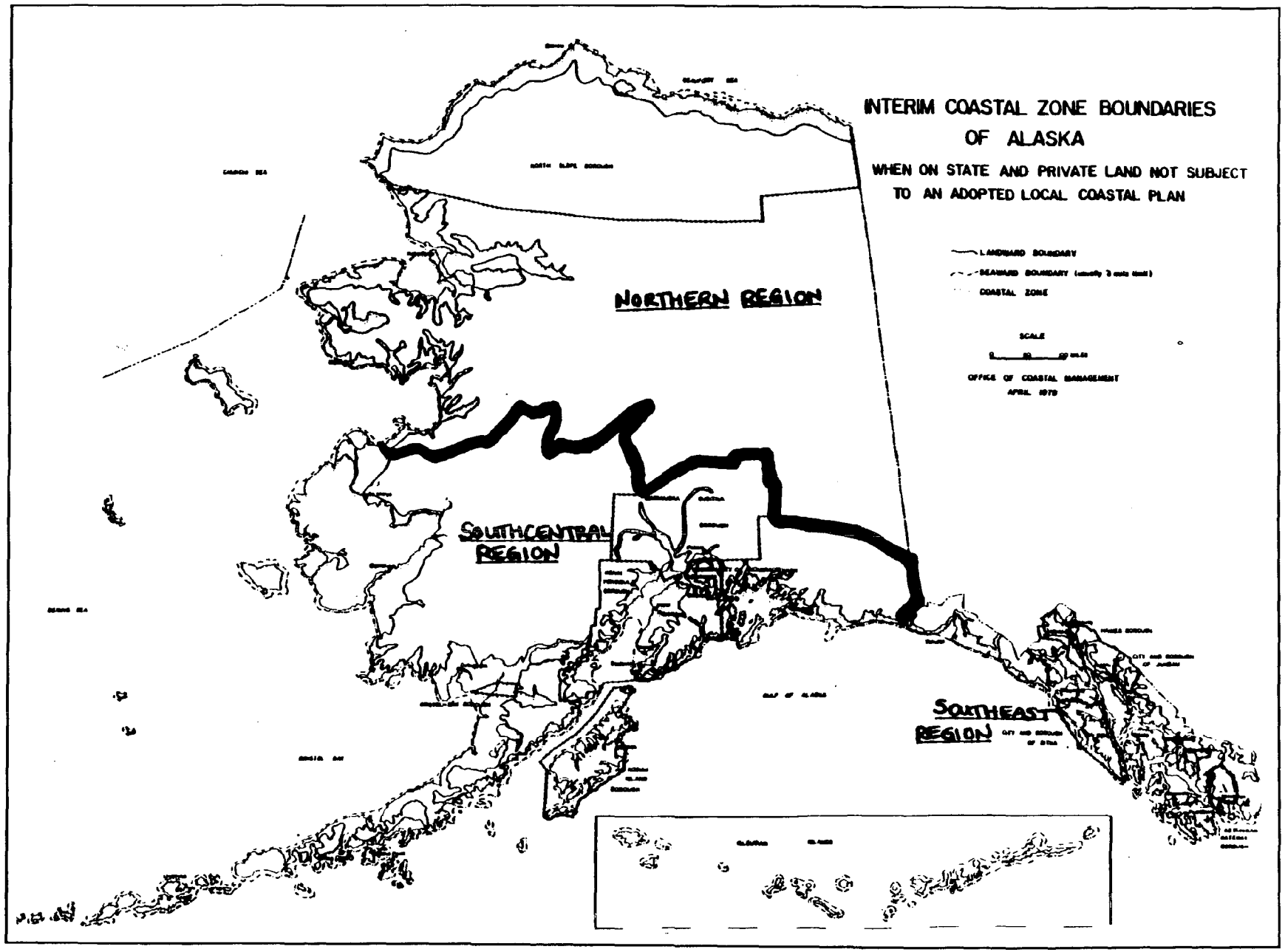
Certification Statement

The information contained herein is true and complete to the best of my knowledge. I certify that the proposed activity complies with, and will be conducted in a manner consistent with, the Alaska Coastal Management Program.

_____ _____

Signature of Applicant or Agent Date

To complete your packet, please attach your state permit applications and copies of your federal applications to this questionnaire.


INTERIM COASTAL ZONE BOUNDARIES
OF ALASKA
WHEN ON STATE AND PRIVATE LAND NOT SUBJECT
TO AN ADOPTED LOCAL COASTAL PLAN
NORTHERN REGION
SOUTHCENTRAL
REGION
SOUTHEAST
REGION

SOUTHEAST REGIONAL CONTACTS

DEPARTMENT OF NATURAL RESOURCES

Oil & Gas Activities

DNR/Commissioner's Office
400 Willoughby Ave.
Juneau, AK 99801-1796
(907) 465-2400
CONTACT: Jim Powell

Mining Activities

DNR/Mining*
Box 107016
Anchorage, AK 99510-7016
(907) 762-2163
CONTACT: Jerry Gallagher

Forestry Activities

DNR/Forestry
400 Willoughby Avenue
Juneau, AK 99801-1796
(907) 465-2491
CONTACT: Jim McAllister

Agriculture Activities

DNR/Agriculture
915 S. Bailey
P.O. Box 949
Palmer, AK 99645-0949
(907) 745-7200
CONTACT: Mark Weaver

Activities on State Park Lands

DNR/Parks
400 Willoughby Avenue
Juneau, AK 99801-1796
(907) 465-4563
CONTACT: Linda Kruger

All Other Activities

Southeast District Office
DNR/Land and Water Management
400 Willoughby Avenue
Juneau, AK 99801-1796
(907) 465-3400
CONTACT: Andy Pekovitch

*Street Address:

3601 "C" Street
Frontier Building

DEPARTMENT OF FISH AND GAME

DFG/Habitat Division

P.O. Box 20
Douglas, AK 99824-0020
(907) 465-4290, 465-4291
CONTACT: Rick Reed or
Janet Hall

Area Offices

Department of Fish and Game
P.O. Box 667
Petersburg, AK 99833
(907) 772-3801
CONTACT: Don Cornelius

Department of Fish and Game
2030 Sealevel Drive, Room 205
Ketchikan, AK 99901
(907) 225-2027
CONTACT: Jack Gustafson

Department of Fish and Game
State Office Building
P.O. Box 510
Sitka, AK 99835
(907) 747-5828
CONTACT: Dave Hardy

Hatchery Permits

DFG/FRED Division
1255 West Eighth Street
P.O. Box 3-2000
Juneau, AK 99802-2000
(907) 465-4160
CONTACT: Jerry Madden or
Kevin Duffy

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DEC/Southeast Office
P.O. Box 2420
9000 Old Glacier Highway
Juneau, AK 99803
(907) 789-3151
CONTACT: Dick Stokes

OFFICE OF MANAGEMENT AND BUDGET

Division of Governmental Coordination
Pouch AW
431 N. Franklin Street
Juneau, AK 99811-0165
(907) 465-3562
CONTACT: Diane Mayer
Lorraine Marshall

SOUTHCENTRAL REGIONAL CONTACTS

DEPARTMENT OF NATURAL RESOURCES

Oil & Gas Activities

DNR/Oil and Gas*
Box 107034
Anchorage, AK 99510-7034
(907) 762-2547
CONTACT: Bill Van Dyke

Mining Activities

DNR/Mining*
Box 107016
Anchorage, AK 99510-7016
(907) 762-4222
CONTACT: Jerry Gallagher

Forestry Activities

DNR/Forestry*
Box 107005
Anchorage, AK 99510-7005
(907) 762-2123
CONTACT: Dan Ketchum

Agriculture Activities

DNR/Agriculture
915 S. Bailey
P.O. Box 949
Palmer, AK 99645
(907) 745-7200
CONTACT: Dean Brown

Activities on State Park Lands

DNR/Parks*
Box 107001
Anchorage, AK 99510-7001
(907) 762-4565
CONTACT: Al Miners

All Other Activities

Public Information*
Southcentral District Office
DNR/Land and Water Management
Box 107005
Anchorage, AK 99510-7005
(907) 762-2270
CONTACT: Janetta Pritchard

*Street Address:

3601 "C" Street
Frontier Building

DEPARTMENT OF FISH AND GAME

DFG/Habitat Division
333 Raspberry Road
Anchorage, AK 99518-1599
CONTACT: (Southcentral):
Phil Brna
Gary Liepitz
(907) 267-2284
(Southwest and Western):
Denby Lloyd
Kim Sundberg
(907) 267-2346

Hatchery Permits

DFG/FRED Division
1255 West Eighth Street
P.O. Box 3-2000
Juneau, AK 99802-2000
(907) 465-4160
CONTACT: Jerry Madden or
Kevin Duffy

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DEC/Southcentral Office
437 E Street, Second Floor
Anchorage, AK 99501
274-2533
CONTACT: Bob Flint

OFFICE OF MANAGEMENT AND BUDGET

Division of Governmental Coordination
2600 Denali Street, Suite 700
Anchorage, AK 99503-2798
(907) 274-1581
CONTACT: Patty Bielawski
Louisa Rand

NORTHERN REGIONAL CONTACTS

DEPARTMENT OF NATURAL RESOURCES

Oil & Gas Activities

DNR/Oil and Gas*
Box 107034
Anchorage, AK 99510-7034
(907) 762-2547
CONTACT: John Wharam

Mining Activities

DNR/Mining*
Box 107016
Anchorage, AK 99510-7016
(907) 762-4222
CONTACT: Jerry Gallagher

Forestry Activities

DNR/Forestry*
Box 107005
Anchorage, AK 99510-7005
(907) 762-4500
CONTACT: Dan Ketchum

Agriculture Activities

DNR/Agriculture
915 S. Bailey
P.O. Box 949
Palmer, AK 99645
(907) 745-7200
CONTACT: Mark Weaver

Activities on State Park Lands

DNR/Parks
4418 Airport Way
Fairbanks, AK 99709
(907) 479-4136
CONTACT: Al Meiners or Dave Snarski

All Other Activities

North Central District Office
DNR/Land and Water Management
4420 Airport Way
Fairbanks, AK 99709
(907) 479-2243
CONTACT: Gayle Berger

*Street Address:

3601 "C" Street
Frontier Building

DEPARTMENT OF FISH AND GAME

DFG/Habitat Division
1300 College Road
Fairbanks, AK 99709
CONTACT: Al Ott
(907) 452-1531

Hatchery Permits

DFG/FRED Division
1255 West Eighth Street
P.O. Box 3-2000
Juneau, AK 99802-2000
(907) 465-4160
CONTACT: Jerry Madden or
Kevin Duffy

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DEC/Northern Office
1001 Noble Street, Suite 350
Fairbanks, AK 99701
(907) 452-1714
CONTACT: Paul Bateman (Arctic)
Joyce Beelman (Interior)

OFFICE OF MANAGEMENT AND BUDGET

Division of Governmental Coordination
675 Seventh Avenue, Station H
Fairbanks, AK 99701-4596
(907) 451-2818
CONTACT: Elizabeth Benson
Patti Wightman

Appendix D

Consolidated Shellfish Permit Application

STATE OF ALASKA

STEVE COWPER, GOVERNOR

OFFICE OF THE GOVERNOR

DIVISION OF GOVERNMENTAL COORDINATION

CENTRAL OFFICE
P.O. BOX AW
JUNEAU, ALASKA 99811-0165
PHONE: (907) 465-3562

SOUTHEAST REGIONAL OFFICE
431 NORTH FRANKLIN
P.O. BOX AW, SUITE 101
JUNEAU, ALASKA 99811-0165
PHONE: (907) 465-3562

SOUTHCENTRAL REGIONAL OFFICE
2600 DENALI STREET
SUITE 700
ANCHORAGE, ALASKA 99503-2798
PHONE: (907) 274-1581

NORTHERN REGIONAL OFFICE
675 SEVENTH AVENUE
STATION H
FAIRBANKS, ALASKA 99701-4596
PHONE: (907) 456-3084

Dear Shellfish Farm Applicant:

The Shellfish Farm Application is designed to help you obtain the authorizations routinely required by the State of Alaska Departments of Natural Resources (DNR), Fish and Game (DFG), Environmental Conservation (DEC), and Division of Governmental Coordination (DGC) to site and construct your shellfish mariculture project. This form can be used to apply for the Shellfish Farm Permit or Fish Habitat Permits from DFG, Water Quality Certification (401) and System Plan Review Approvals from DEC, Land Use Permits and Leases from DNR, and the Coastal Zone Consistency Certification from DGC. It also addresses your use and discharge of up to 500 gallons per day of fresh water and solid waste disposal for single family use.

A Coastal Project Questionnaire, which is available from any of these agency offices, must also be submitted with your application to help determine which specific permits must be obtained prior to constructing your project. If you determine that your specific project design requires additional permits for activities such as an increase in water use, discharge or solid waste disposal, or use of state owned timber or gravel you must also file supplementary applications with the standard Shellfish Farm Application.

Please read this application carefully. A fully completed application will help the state agencies to process your request promptly. Incomplete or incorrect information may result in requests for additional information, processing delays, or the application may be returned to you for resubmission. You will receive a notice and processing schedule for the state coastal zone consistency review from DGC when your application has been accepted for processing. Your permits will also be processed on this schedule.

If you need technical assistance in completing this application, please refer to the list of agency representatives provided at the back of the coastal project questionnaire. If you have questions about this application process, or you are not able to determine which agency can best answer your technical questions, contact the Division of Governmental Coordination in Juneau at 465-3562, in Anchorage at 274-1581, or in Fairbanks at 451-2818.

Stocking your Farm or Selling your Products.
In addition to the permits and approvals which you are applying for in this consolidated permit application, you will also need to separately apply for and obtain a Fish Transport Permit from ADF&G to obtain and hold broodstock, and a Growing-Area Certification and a Harvester's Permit from DEC in order to sell your product. These permits are not covered by this application since they are required for later phases of your project.

A Fish Transport Permit is required by ADF&G in order to hold, transport, and raise live fish including shellfish. You will need this permit before you can obtain, hold, or begin raising your product. We encourage you to contact the Fisheries Rehabilitation, Enhancement and Development (FRED) Division in Juneau at 465-4160 or in Anchorage at 267-2157 as early as possible in order to apply for and obtain a Fish Transport Permit.

You should contact DEC regarding area certification requirements so that you can be reasonably sure that your site will qualify. We recommend that you apply for growing area certification and a harvester's permit at least six months before you intend to harvest shellfish. To obtain more information on certification requirement please contact DEC in Anchorage at 563-0318.

State of Alaska

Consolidated Shellfish Farm Permit Application

General Instructions

1. Fill in the blanks on the form provided.

2. If additional space is needed to fully answer a particular question, attach additional pages marked with the corresponding number in the application.

3. Applications must be typed or printed **clearly** in **ink.**

4. Applications must be **signed** by the applicant or an authorized representative.

5. The application and a **coastal project questionnaire** must be sent to the Office of Management and Budget's, Division of Governmental Coordination in the region in which the farm is to be located.

OMB/DGC
Southeast Regional Office
431 North Franklin Street
P.O. Box AW, Suite 101
Juneau, Alaska 99811-0165
(907) 465-3562

OMB/DGC
Southcentral Regional Office
2600 Denali Street
Suite 700
Anchorage, Ak 99503-2798
(907) 274-1581

OMB/DGC
Northern Regional Office
675 Seventh Avenue
Station H
Fairbanks, AK99701-4596
(907) 451-2818

6. The Department of Natural Resources requires an application **filing fee** of $50. Please submit the filing fee along with a copy of your completed application to the appropriate regional office.

DNR
Southeast Regional Office
400 Willoughby Avenue
Suite 400
Juneau, Alaska 99801

DNR
Southcentral Regional Office
3601 C Street, Anchorage
Mailing Address:
P.O. Box 107005
Anchorage, Alaska 99510

DNR
Northern Regional Office
4420 Airport Way
Fairbanks, Alaska 99709

7. ***Please note:*** This application is for a specific mariculture project. You will need to submit a new application if you change any of the following:

   A. The species to be propogated
   B. The size or design of your operation
   C. The location of your operation
   D. Request a long-term tidelands lease for a previously permitted site

PERMIT APPLICATION
State of Alaska Consolidated Shellfish Farm

APPLICANT INFORMATION

1. _____
Name

_____
Mailing Address

_____
City State Zip Code

_____
Phone

2. _____
Business Name (if applicable)

_____
Business Address

_____
City State Zip Code

_____
Phone

3. _____
Authorized Agent (if applicable)

_____
Address

_____
City State Zip Code

_____
Phone

PROJECT INFORMATION

1. Provide a brief description of the facility and your overall proposal. Include upland facilities as well as tide and submerged land facilities.

_____

_____

_____

2. What experience, expertise, and other resources do you have available for this project?

_____

_____

_____

PROJECT LOCATION

1. Is the Project on: (please mark with ✓)

State Land _____ Federal Land _____ Private Land _____ Municipal Land _____

2. Township _____ Range _____ Meridian _____ Section _____

3. Number of acres applied for:

Uplands _____ Tidelands _____

4. Provide the names and addresses of the landowners of adjacent uplands and tidelands.

Uplands	Tidelands
A _____	A _____
B _____	B _____
C _____	C _____

5. Attach topographic maps (U.S.G.S. Scale 1; 63360) and nautical charts to this application that show the site location and general area. Clearly indicate the site location on the charts and maps.

C. If there is a caretaker's facility proposed for the site, please submit the following information for review of your sewage disposal system plan:

(Note: outhouses and septic systems must maintain a minimum 100 foot horizontal separation distance from surface waters and a minimum of 4 foot vertical separation distance from the high ground water table.)

1. The location and description of proposed and existing domestic wastewater treatment works, disposal systems, or sewers;
2. the location of waters, including any drinking water wells, fresh water, salt water within 200 feet of the proposed wastewater disposal system;
3. the proposed discharge location;
4. (if disposal is into subsurface land) the soil information used to determine absorption-field area required for domestic wastewater disposal systems, including soil tests, borings, test holes, and percolation tests.

CURRENT LAND USE STATUS

Describe the type and intensity of all present uses of the project site and the surrounding area (e.g. commercial development, mining, timber harvest or transfer, sheltered anchorage, subsistence, recreation, commercial fishing, sport fishing, or residential use, etc.).

_____

_____

_____

FARM OPERATION AND DEVELOPMENT

1. Species to be raised:

	Species	Annual Production Goal
A	_____	_____
B	_____	_____
C	_____	_____

2. Please provide a timetable showing approximate dates for installation of spat collection gear, placement of production facilities, date of first sale, and a schedule for reaching expected maximum production.

_____

_____

_____

3. Donor Stock

Have you submitted a Fish Transport Permit application to the Department of Fish and Game?
yes____ no____

If yes, date of application _____

Certification Statement

The information contained herein is true and complete to the best of my knowledge. I understand that I must separately apply for and hold a Fish Transport Permit from the Department of Fish and Game in order to hold, transport, and raise shellfish, and a Growing Area Certification and a Harvesters Permit from the Department of Environmental Conservation in order to sell my product.

_____ _____

Signature of Applicant or Agent Date

E. Do anadromous fish (e.g. salmon) use any streams in the area for spawning? yes____ no____

If yes, indicate which streams are used and label them as such on the site plan.

F. Is the target species naturally present in the area? yes____ no____

If yes, describe abundance and condition.

G. Describe measures you would propose to control predation by marine mammals, seabirds, or other potential predators.

WATER QUALITY

NOTE TO APPLICANT: Sewage or industrial discharge(s) may accumulate in, or harm the growth or consumptive use of your shellfish product. Oysters, mussels and scallops are filter feeders and may accumulate fecal coliform bacteria from sewage discharges. If a caretaker facility is located near the culturing operation there may be a risk of contamination. DEC will require that the wastewater treatment systems used on caretaker facilities meet Alaska State Water Quality Standards criteria for harvest or consumption of raw mollusks or other aquatic life.

A. Were there any sources of past pollution at the site, such as a shorebased seafood processor, industrial facility, or a town or village? yes____ no____

If you answered yes to the above, identify:

- The type of previous use (i.e. mine, village, seafood processor) _____
- The last known date of use _____
- The distance from site of previous use to your project site _____

B. Are there any currently active sources of human or industrial pollution in the area? yes____ no____

If yes, please describe:

- The type of discharge(s) _____
- The location and distance from your site _____
- The name of the discharger(s), if known _____

SITE PLAN & PHYSICAL DESCRIPTION

1. Provide a site plan drawn to scale (no less than 1" = 50') which shows the layout and location of the following:

   A. The rafts or other production facilities employed (please include size and number).
   B. Anchoring systems and shoreties.
   C. Docks, floathomes, or caretaker facilities, including source of freshwater for domestic use and processing water, wastewater disposal systems, and solid waste storage and disposal. (Note: you are encouraged to use existing permitted sites for the disposal of solid wastes.)
   D. Any freshwater discharges.
   E. Roads or air strips.
   F. Other upland or tideland facilities at the site associated with the farming operation.
   G. Fuel and chemical storage.
   H. Properties referenced in #4 of the previous section.

2. On the site plan, draw lines and identify the tide level at the following stages:

   - Mean Lower Low Water (MLLW)
   - Mean Higher High Water (MHHW)
   - Mean High Water (MHW)

3. Diagram surface tidal current speed and direction at maximum tide flow on the site plan or nautical chart.

4. Water depth at the site of culture gear at MLLW would be: _____

SITE SUITABILITY

1. Physical and Biological Characteristics

   A. Have you conducted an on-site investigation? yes____ no____

   B. Provide any information you may have regarding tidal flushing, water temperature, salinity, and turbidity/sedimentation at the site. Include the dates these data were obtained.

   _____

   _____

   _____

   C. Describe the bottom type composition at the site (if more than one type, indicate percent).

   sand____ mud____ rock____ gravel____ eelgrass____

   other: _____

   _____

   _____

   D. Describe winter conditions at the site (temperatures, icing, storms, etc.).

   _____

   _____

   _____

Appendix E

STATE OF ALASKA PERMIT / LEASE AGENCY CONTACT LIST

Dept. of Natural Resources

Oil and Gas Activities

DNR / Oil & Gas
400 Willoughby
Juneau, AK 99801
(907) 465-2400

Mining Activities

DNR / Mining
Box 7016
Anchorage, AK 99510
(907) 762-4222

Activities in State Parks

DNR / Parks
400 Willoughby
Juneau, AK 99801
(907) 465-4563

Forestry Activities

DNR / Forestry
400 Willoughby
Juneau, AK 99801
(907) 465-4500

Agricultural Activities

DNR / Agriculture
915 S. Bailey
P.O. Box 949
Palmer, AK 99645
(907) 745-7200

All Other Activities

Southeast District Office
Division of Land & Water
400 Willoughby
Juneau, AK 99645
(907) 465-3400

Dept. of Fish and Game

ADF&G/ Habitat Division
P.O. Box 20
Douglas, AK 99824
(907) 465-4290

Area Offices
ADF&G
P.O. Box 667
Petersburg, Alaska 99833
(907) 772-3801

ADF&G
State Office Building
P.O. Box 510
Sitka, Alaska 99835
(907) 747-5828

Fisheries Rehabilitation
Enhancement & Development
Shellfish Farm Permits
1255 West Eighth St.
Juneau, Alaska 99802
(907) 465-4160

ADF&G
2030 Sealevel Drive Rm205
Ketchikan, AK 99901
(907) 225-2027

Office of Management & Budget

Division of Governmental Coordination
P.O. Box AW
431 N. Franklin Street
Juneau, Alaska 99811
(907) 465-3562

Dept. of Environmental Conservation

DEC / Southeast Office
9000 Old Glacier Highway
Juneau, Alaska 99803
(907) 789-3151

Appendix F

REFERENCES

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Duvall, W.S. and F.F. Slaney Co. 1980. A review of the impacts of log handling on coastal marine environments and resources. Prep. for Envir. Rev. Panel of the COFI/Govt. Estuary, Foreshore, and Water Log Handling and Transportation Study. Vancouver, B.C. 224 pp.

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David L., Fluharty (editors) El Nino north: Nino effects in the eastern subartic pacific ocean. Washington Sea Grant Program, University of Washington, Seattle.

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PERSONAL COMMUNICATIONS

John Church, former oyster grower in Blashke Islands, Wrangell, Alaska

Dr. Louis Druehl, researcher at Nanaimo Research Station, British Columbia.

Dr. Jim Hemming, mussel grower, Kachemak Bay, Alaska.

Eric Hurlburt, Shellfish/Aquaculture Coordinator, Washington Dept. of Fisheries, Olympia, Washington

Dr. Michael Kaill, Mariculture Coordinator, Fisheries Rehabilitation, Enhancement and Development Division, Alaska Dept. of Fish and Game, Juneau, Alaska

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Appendix G Senate Bill 514

Offered: 5/9/88 5-2170X
For Today's Supplemental Calendar
Original sponsor: Rules Committee

IN THE SENATE BY THE RULES COMMITTEE

HOUSE CS FOR CS FOR SENATE BILL NO. 514 (Rules)

IN THE LEGISLATURE OF THE STATE OF ALASKA

FIFTEENTH LEGISLATURE - SECOND SESSION

A BILL

For an Act entitled: "An Act relating to the farming of aquatic plants and shellfish; prohibiting the farming of Atlantic salmon; extending the moratorium on finfish farming until July 1, 1990; establishing the Alaska Finfish Farming Task Force; and providing for an effective date."

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

* Section 1. FINDINGS AND POLICY. (a) The legislature finds that

(1) aquatic farming in the state would

(A) provide a consistent source of quality food;

(B) provide new jobs;

(C) increase state exports;

(D) create new business opportunities; and

(E) increase the stability and diversity of the state's economy; and

(2) development of aquatic farming in the state would increase the availability of fresh seafood to Alaskans and would strengthen the competitiveness of Alaska seafood in the world marketplace by broadening the diversity of products and providing year-round supplies of premium quality seafood.

(b) It is the policy of the state

(1) to encourage the establishment and responsible growth of an aquatic farming industry in the state; and

(2) that allocation of aquatic farming sites be made with full

consideration of established and ongoing activities in an area.

* Sec. 2. AS 16.40 is amended by adding new sections to read:

ARTICLE 2. AQUATIC FARMING.

Sec. 16.40.100. AQUATIC FARM AND HATCHERY PERMITS. (a) A person may not, without a permit from the commissioner, construct or operate

(1) an aquatic farm; or

(2) a hatchery for the purpose of supplying aquatic plants or shellfish to an aquatic farm.

(b) A permit issued under this section authorizes the permittee, subject to the conditions of AS 03.05 and AS 16.40.100 - 16.40.199, to acquire, purchase, offer to purchase, transfer, possess, sell, and offer to sell stock and aquatic farm products that are used or reared at the hatchery or aquatic farm. A person who holds a permit under this section may sell or offer to sell shellfish stock to the department or to an aquatic farm or related hatchery outside of the state.

(c) The commissioner may attach conditions to a permit issued under this section that are necessary to protect natural fish and wildlife resources.

(d) Notwithstanding other provisions of law, the commissioner may not issue a permit under this section for the farming of, or hatchery operations involving, Atlantic salmon.

Sec. 16.40.105. CRITERIA FOR ISSUANCE OF PERMITS. The commissioner shall issue permits under AS 16.40.100 on the basis of the following criteria:

(1) the physical and biological characteristics of the proposed farm or hatchery location must be suitable for the farming of the shellfish or aquatic plant proposed;

(2) the proposed farm or hatchery may not require

significant alterations in traditional fisheries or other existing uses of fish and wildlife resources;

(3) the proposed farm or hatchery may not significantly affect fisheries, wildlife, or their habitats in an adverse manner; and

(4) the proposed farm or hatchery plans and staffing plans must demonstrate technical and operational feasibility.

Sec. 16.40.110. PERMIT APPLICATION, RENEWAL, AND TRANSFER. (a) An applicant for an aquatic farming or hatchery permit required under AS 16.40.100 shall apply on a form prescribed by the commissioner. An application for a permit must include a plan for the development and operation of the aquatic farm or hatchery, which must be approved by the commissioner before the permit is issued.

(b) An application for renewal or transfer of a permit must be accompanied by fees required by the commissioner, a report of the disease history of the farm or hatchery covered by the permit, and evidence that satisfies the commissioner that the applicant has complied with the development plan required under (a) of this section. The commissioner may require a health inspection of the farm or hatchery as a condition of renewal. The department may conduct the inspection or contract with a disease diagnostician to conduct the inspection.

(c) A person to whom a permit is transferred may use the permit only for the purposes for which the permit was authorized to be used by the transferor, and subject to the same conditions and limitations.

Sec. 16.40.120. AQUATIC STOCK ACQUISITION PERMITS. (a) A person may not acquire aquatic plants or shellfish from wild stock in the state for the purpose of supplying stock to an aquatic farm or hatchery required to have a permit under AS 16.40.100 unless the

person holds an acquisition permit from the commissioner.

(b) An acquisition permit authorizes the permit holder to acquire the species and quantities of wild stock in the state specified in the permit for the purposes of supplying stock to

(1) an aquatic farm or hatchery required to have a permit under AS 16.40.100;

(2) the department.

(c) The commissioner shall specify the expiration date of an acquisition permit and may attach conditions to an acquisition permit, including conditions relating to the time, place, and manner of harvest. Size, gear, place, time, licensing, and other limitations applicable to sport, commercial, or subsistence harvest of aquatic plants and shellfish do not apply to a harvest with a permit issued under this section. The commissioner of fish and game shall issue or deny a permit within 30 days after receiving an application.

(d) The commissioner shall deny or restrict a permit under this section upon finding that the proposed harvest will impair sustained yield of the species or will unreasonably disrupt established uses of the resources by commercial, sport, personal use, or subsistence users. The commissioner shall inform the Board of Fisheries of any action taken on permit applications for species that support commercial fisheries subject to limited entry under AS 16.43 and of any permits denied because of unreasonable disruption of an established use. A denial of the permit by the commissioner must contain the factual basis for the findings.

(e) The Board of Fisheries may adopt regulations for the conservation, maintenance, and management of species for which an acquisition permit is required.

(f) Except as provided in (d) of this section or in a regulation

adopted under (e) of this section, the commissioner shall issue a permit if

(1) wild stock is necessary to meet the initial needs of farm or hatchery stock;

(2) there are technological limitations on the propagation of cultured stock for the species sought;

(3) wild stock sought is not fully utilized by commercial, sport, personal use, or subsistence fisheries; or

(4) wild stock is needed to maintain the gene pool of a hatchery or aquatic farm.

(g) Aquatic plants and shellfish acquired under a permit issued under this section become the property of the permit holder and are no longer a public or common resource.

Sec. 16.40.130. IMPORTATION OF AQUATIC PLANTS OR SHELLFISH FOR STOCK. A person may not import into the state an aquatic plant or shellfish for the purpose of supplying stock to an aquatic farm or hatchery unless authorized by a regulation of the Board of Fisheries.

Sec. 16.40.140. LIMITATION ON SALE, TRANSFER OF STOCK, AND PRODUCTS. (a) A private hatchery required to have a permit under AS 16.40.100 may sell or transfer stock from the hatchery only to an aquatic farm or other hatchery that has a permit issued under AS 16.-40.100, except that shellfish stock may also be sold or offered for sale to an aquatic farm or related hatchery outside of the state.

(b) Stock may not be transferred to or from an aquatic farm or hatchery required to have a permit under AS 16.40.100 without prior notice of the transfer to the commissioner. A notice of transfer shall be submitted at least 45 days before the proposed date of transfer.

(c) A notice of transfer must be accompanied by a report of a

health inspection of the stock. The department shall conduct the inspection or contract with a disease diagnostician to conduct the inspection. The cost of inspection shall be borne by the department.

(d) The department may restrict or disapprove a transfer of stock if it finds that the transfer would present a risk of spreading disease.

(e) A person may not sell, transfer, or offer to sell or transfer, or knowingly purchase or receive, an aquatic farm product grown or propagated in the state unless the product was grown or propagated on a farm with a permit issued under AS 16.40.100. The permit must be in effect at the time of the sale, transfer, purchase, receipt, or offer.

Sec. 16.40.150. DISEASE CONTROL AND INSPECTION. (a) The department shall order the quarantine or the destruction and disposal of diseased hatchery stock or of aquatic farm products when necessary to protect wild stock. A holder of a permit issued under AS 16.40.100 shall report to the department an outbreak or incidence of disease among stock or aquatic farm products of the permit holder within 48 hours after discovering the outbreak or incidence.

(b) A holder of a permit issued under AS 16.40.100 shall allow the department to inspect the permit holder's farm or hatchery during operating hours and upon reasonable notice. The cost of inspection shall be borne by the department.

(c) The department shall develop a disease management and control program for aquatic farms and hatcheries.

(d) The department may enter into an agreement with a state or federal agency or a private, state-certified provider to provide services under (b) and (c) of this section, or inspections under AS 16.40.110(b).

Sec. 16.40.160. REGULATIONS. The commissioner may adopt regulations necessary to implement AS 16.40.100 - 16.40.199.

Sec. 16.40.170. PENALTY. A person who violates a provision of AS 16.40.100 - 16.40.199, a regulation adopted under AS 16.40.100 - 16.40.199, or a term or condition of a permit issued under AS 16.40.-100 - 16.40.199, is guilty of a class B misdemeanor.

Sec. 16.40.199. DEFINITIONS. In AS 16.40.100 - 16.40.199

(1) "aquatic farm" means a facility that grows, farms, or cultivates aquatic farm products in captivity or under positive control;

(2) "aquatic farm product" means an aquatic plant or shellfish, or part of an aquatic plant or shellfish, that is propagated, farmed, or cultivated in an aquatic farm and sold or offered for sale;

(3) "aquatic plant" means a plant indigenous to state water or that is authorized to be imported into the state under a permit issued by the commissioner;

(4) "commissioner" means the commissioner of fish and game;

(5) "hatchery" means a facility for the artificial propagation of stock, including rearing of juvenile aquatic plants or shellfish;

(6) "positive control" means, for mobile species, enclosed within a natural or artificial escape-proof barrier; for species with limited or no mobility, such as a bivalve or an aquatic plant, "positive control" also includes managed cultivation in unenclosed water;

(7) "shellfish" means a species of crustacean, mollusk, or other invertebrate, in any stage of its life cycle, that is indigenous to state water or that is authorized to be imported into the state under a permit issued by the commissioner;

(8) "stock" means live aquatic plants or shellfish

acquired, collected, possessed, or intended for use by a hatchery or aquatic farm for the purpose of further growth or propagation.

* Sec. 3. AS 03.05.011(a) is amended to read:

(a) To carry out the requirements of this title, the commissioner of environmental conservation may issue orders, regulations, permits, quarantines, and embargoes relating to

(1) examination and inspection of premises containing products, articles, and commodities carrying pests;

(2) establishment of quarantines for eradication of pests;

(3) establishment of standards and labeling requirements pertaining to the sale of meat, fish, and poultry;

(4) tests and analyses which may be made and hearings which may be held to determine whether the commissioner will issue a stop order or quarantine;

(5) cooperation with federal and other state agencies;

(6) regulation of fur farming; for purposes of this paragraph, "fur farming" means the raising of and caring for animals for the purpose of marketing their fur, or animals themselves for breeding stock;

(7) examination and inspection of meat, fish, and poultry advertised for sale or sold to the public;

(8) enforcement of quality assurance plans developed in cooperation with appropriate industry representatives;

(9) establishment of standards and conditions for the operation and siting of aquatic farms and related hatcheries, including

(A) restrictions on the use of chemicals; and

(B) requirements to protect the public from contaminated aquatic farm products that pose a risk to health;

(10) monitoring aquatic farms and aquatic farm products to ensure compliance with this chapter and with the requirements of the national shellfish sanitation program manual of operations published by the Food and Drug Administration.

* Sec. 4. AS 03.05.040(a) is amended to read:

(a) On any business day during the usual hours of business the commissioner or an authorized inspector may, for the purpose of inspecting agricultural, [OR] fisheries, or aquatic farm products or aquatic farm sites subject to regulation, enter a storehouse, warehouse, cold storage plant, packing house, slaughterhouse, retail store or other building or place where those products are kept, stored, processed or sold.

* Sec. 5. AS 03.05.100 is amended to read:

Sec. 03.05.100. DEFINITIONS. In this chapter,

(1) "agricultural products" does not include fish or fisheries products;

(2) "aquatic farm" and "aquatic farm product" have the meanings given in AS 16.40.199;

(3) "fish or fisheries products" means any aquatic animal, including amphibians, or aquatic plants or parts of those plants, animals or amphibians that are usable as human food.

* Sec. 6. AS 16.05.050 is amended by adding a new paragraph to read:

(17) to permit and regulate aquatic farming in the state in a manner that ensures the protection of the state's fish and game resources and improves the economy, health, and well-being of the citizens of the state;

* Sec. 7. AS 16.05.251 is amended by adding a new subsection to read:

(f) Except as expressly provided in AS 16.40.120(d) and (e) and 16.40.130, the Board of Fisheries may not adopt regulations or take

action regarding the issuance, denial, or conditioning of a permit under AS 16.40.100 or 16.40.120, the construction or operation of a farm or hatchery required to have a permit under AS 16.40.100, or a harvest with a permit issued under AS 16.40.120.

* Sec. 8. AS 16.05.930 is amended by adding a new subsection to read:

(g) AS 16.05.330 - 16.05.720 do not apply to an activity authorized by a permit issued under AS 16.40.100 or 16.40.120, or to a person or vessel employed in an activity authorized by a permit issued under AS 16.40.100 or 16.40.120.

* Sec. 9. AS 16.05.940(14) is amended to read:

(14) "fish or game farming" means the business of propagating, breeding, raising, or producing fish or game in captivity for the purpose of marketing the fish or game or their products, and "captivity" means having the fish or game under positive control, as in a pen, pond, or an area of land or water <u>that</u> [WHICH] is completely enclosed by a generally escape-proof barrier; <u>in this paragraph, "fish" does not include shellfish, as defined in AS 16.40.199;</u>

* Sec. 10. AS 16.10 is amended by adding a new section to read:

Sec. 16.10.269. LIMITATIONS. AS 16.10.265 - 16.10.267 do not apply to the purchase or sale of aquatic farm products from a holder of a permit issued under AS 16.40.100 or stock from a holder of a permit issued under AS 16.40.120.

* Sec. 11. AS 16.43.140 is amended by adding a new subsection to read:

(d) This chapter does not apply to activities authorized by a permit issued under AS 16.40.100 or 16.40.120.

* Sec. 12. AS 16.51.180(5) is amended to read:

(5) "seafood" means finfish, shellfish, and fish by-products, including but not limited to salmon, halibut, herring, flounder, crab, clam, cod, shrimp, and pollock<u>, but does not include aquatic</u>

farm products as defined in AS 16.40.199;

* Sec. 13. AS 38.05 is amended by adding a new section to read:

Sec. 38.05.083. AQUATIC FARMING AND HATCHERY SITE LEASES. (a) The commissioner may offer to the public for lease a site that has been developed for aquatic farming or related hatchery operations under a permit issued under AS 38.05.856. Before offering the site to the public, the commissioner shall offer the site to the permittee.

(b) A site shall be leased under this section for not less than the appraised fair market value of the lease. The value of the lease shall be reappraised every five years.

(c) A lease under this section may be assigned, but if the assignee changes the use of the site the lease reverts to the state.

(d) Before entering into a lease under this section, the commissioner shall require the lessee to post a performance bond or provide other security to cover the costs to the department of restoring the leased site in the event the lessee abandons the site.

* Sec. 14. AS 38.05 is amended by adding new sections to read:

Sec. 38.05.855. IDENTIFICATION OF SITES FOR AQUATIC FARMS AND HATCHERIES. (a) The commissioner shall identify districts in the state within which sites may be selected for the establishment and operation of aquatic farms and related hatcheries required to have a permit under AS 16.40.100.

(b) The commissioner shall schedule at least one 60-day period each year during which a person may submit an application that identifies a site in a district for which the person wishes to be issued a permit under AS 38.05.856.

(c) Based on applications received under (b) of this section, and after consultation with the commissioner of fish and game and the commissioner of environmental conservation, the commissioner shall

make a preliminary written finding under AS 38.05.035(e) that proposes sites in each district for which permits may be issued under AS 38.-05.856.

(d) After notice is given under AS 38.05.945 and a hearing is held under AS 38.05.946(b), the commissioner shall issue a final written finding under AS 38.05.035(e) that identifies sites in each district for which permits shall be issued under AS 38.05.856 and that specifies conditions and limitations for the development of each site.

Sec. 38.05.856. TIDELAND AND LAND USE PERMITS FOR AQUATIC FARMING. (a) The commissioner may issue a tideland or land use permit for the establishment and operation of an aquatic farm and related hatchery operations. A permit under this section is valid for three years after the date of issuance. The permit may not be transferred.

(b) Before renewing a permit under this section, the commissioner shall allow interested persons to submit written or oral testimony concerning the renewal to the commissioner within 30 days after the date of the notice. The commissioner may hold a hearing to take testimony.

(c) Before issuing or renewing a permit under this section, the commissioner shall consider all relevant testimony submitted under this section or AS 38.05.946(b). The commissioner may deny the application for issuance or renewal for good cause, but shall provide the applicant with written findings that explain the reason for the denial.

(d) Before issuing or renewing a permit under this section, the commissioner shall require the permittee to post a performance bond or provide other security to cover the costs to the department of restoring the permitted site in the event the permittee abandons the site.

(e) The commissioner shall adopt regulations establishing

criteria for the approval or denial of permits under this section and for limiting the number of sites for which permits may be issued in an area in order to protect the environment and natural resources of the area. The regulations must provide for the consideration of upland management policies and whether the proposed use of a site is compatible with the traditional and existing uses of the area in which the site is located.

* Sec. 15. AS 38.05.945(a) is amended to read:

(a) This section establishes the requirements for notice given by the department for the following actions:

(1) classification or reclassification of state land under AS 38.05.300 and the closing of land to mineral leasing or entry under AS 38.05.185;

(2) zoning of land under applicable law;

(3) a decision under AS 38.05.035(e) regarding the sale, lease, or disposal of an interest in state land or resources; [AND]

(4) a competitive disposal of an interest in state land or resources after final decision under AS 38.05.035(e);

(5) a public hearing under AS 38.05.856(b);

(6) a preliminary finding under AS 38.05.035(e) and 38.05.855(c) concerning sites for aquatic farms and related hatcheries.

* Sec. 16. AS 38.05.945 is amended by adding a new subsection to read:

(g) Notice at least 30 days before action under (a)(5) or (6) shall be given to appropriate

(1) regional fish and game councils established under AS 16.05.260; and

(2) coastal resource service areas organized under AS 46.40.110 - 46.40.210.

* Sec. 17. AS 38.05.946 is amended by adding a new subsection to read:

(b) The commissioner shall hold a public hearing in each district identified under AS 38.05.855 within 30 days after giving notice of a preliminary finding under AS 38.05.035(e) and 38.05.855(c) concerning sites for aquatic farms and related hatcheries.

* Sec. 18. Notwithstanding any other provisions of law, a person who is lawfully operating an aquatic farm or related hatchery in the state on the effective date of this Act is entitled to continue lawful operations at the existing site. The person may obtain an initial lease or permit for the person's existing operations under AS 38.05.083 or 38.05.856, enacted by secs. 13 and 14 of this Act, but as a condition of obtaining the lease or permit the person must agree that during the term of the lease or permit the person will not change the use of the site.

* Sec. 19. LAND MANAGEMENT REPORT REQUIRED. The commissioner of natural resources shall submit to the legislature not later than January 30, 1989, a report detailing the department's implementation of AS 38.05.083 and 38.05.856, enacted by secs. 13 and 14 of this Act. The report must include

(1) the number of applications received under AS 38.05.083 and 38.05.856, and the number of leases and permits issued, according to type of aquatic farm product;

(2) the restrictions attached to permits and leases;

(3) a discussion of the system the department implements for issuing leases and tideland and land use permits;

(4) the level of public involvement in the issuance process; and

(5) a discussion of how the program is working, and the department's plans for modifications of the program.

* Sec. 20. ALASKA FINFISH FARMING TASK FORCE. (a) The legislature finds that the farming of finfish raises a series of socio-economic, biological, and environmental issues requiring an in-depth examination.

(b) The Alaska Finfish Farming Task Force is established to study the issue and make a report of findings for administrative and legislative consideration. The governor shall appoint a five-member task force composed of state residents who are not state employees and who represent a broad spectrum of expertise, including one representative of commercial salmon fishermen, one aquatic farming advocate, one private economist, one fisheries biologist, and one public member with no involvement in the seafood or aquatic farming industry.

(c) The task force shall submit an interim report to the legislature not later than January 30, 1989, and a final report to the legislature not later than January 30, 1990. The reports must address finfish farming in the state in freshwater, in marine environments, and in tanks or other enclosed structures that contain marine water and that are located on land, and shall address related hatchery operations. The reports may address other issues the task force considers appropriate. The reports must examine

(1) whether the farming of finfish can be conducted in a manner that protects the health of the state's fishery resources;

(2) criteria for the siting of finfish farms to minimize land use conflicts and to protect the environment;

(3) net economic costs and benefits of finfish farming in the state to state residents, including jobs created or lost for state residents, tax revenue (assuming an appropriate tax rate), cost of state regulation and monitoring, and effects on markets for salmon caught by the state's commercial fishing fleets;

(4) the cost of providing adequate regulation of finfish farming to protect wild stocks, the environment, public health, and existing beneficial uses of the state's coastal water and land, and the role of the private sector in providing pathological and other services;

(5) identification and analysis of appropriate sources of supply of stock for finfish farms, including but not limited to private nonprofit hatcheries, private for-profit hatcheries, and wild stock, and their likely effect on existing state policy; and

(6) strategies for improving the marketability of Alaska salmon, particularly those high-value species competing with farmed salmon for domestic and export sales.

* Sec. 21. Section 4, ch. 70, SLA 1987, is amended to read:

Sec. 4. Section 1 of this Act is repealed July 1, 1990 [1988].

* Sec. 22. This Act takes effect immediately under AS 01.10.070(c).

Appendix H

DEFINITIONS

Aquaculture - The regulation and cultivation of water plants and animals for human use or consumption.

Aquatic Farming - Mariculture

Benthic - Plants or animals "benthos" associated with the bottom of a body of water especially the ocean.

Bottom culture - A traditional method of oyster culture used in the U.S. and British Columbia and for scallop culture in other areas. This method utilizes the intertidal or subtidal zones, e.g. +3 - +5 tidal range for oysters, which is the natural habitat of the oyster. A gravel or firm substrate is preferred for this method for oysters, mud or other soft bottoms are not conducive to oyster growth.

Bouchot culture - A term referring to the method of culture of oysters and mussels developed in France which involves the attachment of netting or strings directly onto wooden poles set in intertidal areas. Prime areas for bouchot culture are larger bays where very wide mud flats exist.

Floating raft culture - Suspended log structures or P.V.C. containers designed to hold grow-out structures for shellfish, or seaweeds, anchored in water sufficient enough to prevent grounding at any tidal stage.

Grow-out - Maturation of cultured organisms to marketable size.

Hanging culture - A culturing method which relies on floatation to suspend cultured organisms in the water column to maximize growth and minimize limiting factors.

Longline - Vertically suspended lines originating from floats, rafts, or lines stretched horizontally between floats or posts embedded in the bottom. This method uses shellfish spat that is attached to conditioned shell, cultch, or young seaweed plants.

Mariculture - Saltwater aquaculture, sea culture. The aquatic farming of organisms, by a variety of methods, to maturation.

Mitigation - Measures or actions that will avoid adverse consequences or result in milder, less severe, or moderate consequences.

Near Bottom culture - Includes a number of methods in which shellfish are elevated off the intertidal or subtidal substrates by structures embedded in the bottom, e.g. trays.

Out-planting - The method of growing cultured organisms to maturity outside of aquatic farm facilities.

Raft culture - A type of culturing method that accommodates culture lines or trays suspended from a simple floating structure that is securely anchored.

State Resource Agencies - The three state departments DNR, DEC, ADF&G, that manage the states natural resources.

Stake Culture - Attachment of mothershell to the top of a stake of wood or plastic pipe driven into the substrate. Shellfish develop in a cluster by this method.

Suspended culture - A floating culture system typically a plastic mesh tray positioned near the surface. This culturing method takes advantage of the warmer surface water, and reduces the cultured species susceptibility to predation.

Terminal Transfer Facility - An area where commodities such as timber or mineral ore are transferred from ground transportation systems to waterborne systems.

Appendix I

ACRONYMS

The following are acronyms commonly used throughout this document:

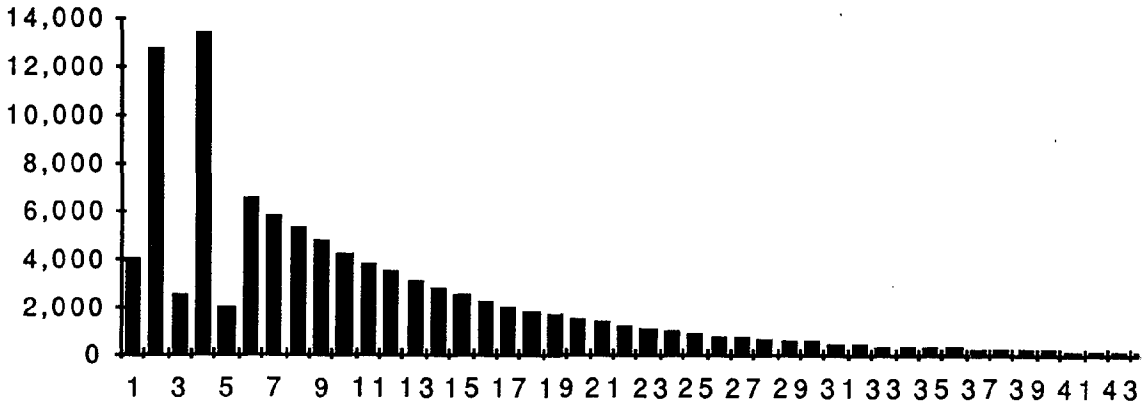
AAC - Alaska Administrative Code
ACMA - Alaska Coastal Management Act
ACMP - Alaska Coastal Management Program
ADF&G - Alaska Department of Fish and Game
AMA - Alaska Mariculture Association
AMSA - Area Meriting Special Attention, an area designation of the ACMA.
AS - Alaska Statute
ASGA - Alaska Shellfish Growers Association
B.C. - British Colombia
COE - U.S. Army Corps of Engineers
CPC - Coastal Policy Council
CPQ - Coastal Project Questionnaire
CSFA - Consolidated Shellfish Farm Application
DCED - Department of Commerce and Economic Development
DEC - Department of Environmental Conservation
DGC - Division of Governmental Coordination of the Office of Management and Budget
DEH - Division of Environmental Health of DEC
DEQ - Division of Environmental Quality of DEC
DNR - Department of Natural Resources
FRED - Fisheries Rehabilitation, Enhancement and Development Division of ADF&G
LUD - Land Use Designation, a land management classification of the USFS.
MAP - Marine Advisory Program of the Extension Service of the University of Alaska
NEPA - National Environmental Protection Agency
NMFS - National Marine Fisheries Service
OFCS - Overseas Fisheries Cooperation Foundation, a quasi-governmental Japanese foun dation that funds projects that will promote international good will.
pH - Product of Hydrogen, a measure of acidity.
PSP - Paralytic Shellfish Poisoning
TLMP - Tongass Land Management Plan
TTF - Terminal Transfer Facility
USFS - United States Forest Service
USF&W - United States Fish and Wildlife Service

Appendix J

Table A-1 Oyster Production-Monthly

This figure represents oyster growth from 14mm spat planted in early May. Production starts as early as the 13th month after spat are planted, and can peak in the 16th month. Harvesting may continue from this crop for 3 years. If smaller spat are used the time to production may be increased from 1 to 11 months and significant mortality may occur.

Oyster Production from 100,000 Spat



Production by Month
If spat planted May '88, production occurs from
May '89 through Dec. '92

Table A-2 Southeast Alaska Raft Culture

Oyster raft culture in Southeast Alaska is shown in Figure B. This method of production is labor intensive with each oyster being handled 6-7 times from when it is planted as spat until it is sold by the farmer. The information for both of these tables was provided by Don Nicholson of Canoe Lagoon Oyster Farm.